RANIGANJ GIRLS' COLLEGE

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DEPARTMENT OF ZOOLOGY

CORE COURSE - III

UNIT - 3

RESPIRATION IN ARTHROPODA

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RESPIRATION IN ARTHROPODA

- **Introduction:**

- Arthropoda is the largest Phylum of the animal kingdom which comprises of 70-80 % of animals.
- They live in diverse types of habitats, thus, developed a wide variety of respiratory systems.

- **Embryonic origin:** The Respiratory system is ectodermal in origin.

- **Respiratory method:**

- The gas exchange takes place across a respiratory surfaces through the **simple diffusion.**

- **Respiratory Surfaces:**

- The primary requirements for efficient gas exchange across the cell surfaces:

✓ **1. Moist surface :** It dissolves the gases across the cell membrane.

✓ **2. Thin surface :** The single cell lining optimizes gas diffusion.

✓ **3. Large surface :** It allow for adequate gas exchange.

✓ **4. Rich blood supply:** It maintains a diffusion gradient.

✓ **5. Direct contact:** The source of O_2 must remain in direct contact.

✓ **6. Ventilation:** The flow of respiratory medium over the respiratory surface.

✓ **7. Examples:** The outer surface, skin, gills, tracheae, and lungs etc.

❑ Respiratory Media:

- Animal can use **water** **or** **air** as the source of O_2.
- In a given volume less O_2 is available in water than in air.
- Obtaining O_2 from water requires greater efficiency than air breathing.

❑ Respiratory pigments:

- They are generally dissolved in the blood plasma.
- The respiratory pigments are:-

✓ Hemocyanin (metalloprotein):

- Most common in many crustaceans & a few centipedes.
- Transport O_2 in the hemolymph.
- Containing copper as O_2 binding agent.

✓ Hemoglobin (metalloprotein):

- Found in a few crustaceans and insects (*Anopheles, Apes* etc.).
- Containing iron as O_2 binding agent.
- Few insects (e.g. blood worm) uses it for storing O_2.

❖ FORMS OF RESPIRATION AND ASSOCIATED ORGANS IN ARTHROPODA:

1. AQUATIC RESPIRATION (absorb oxygen from water):

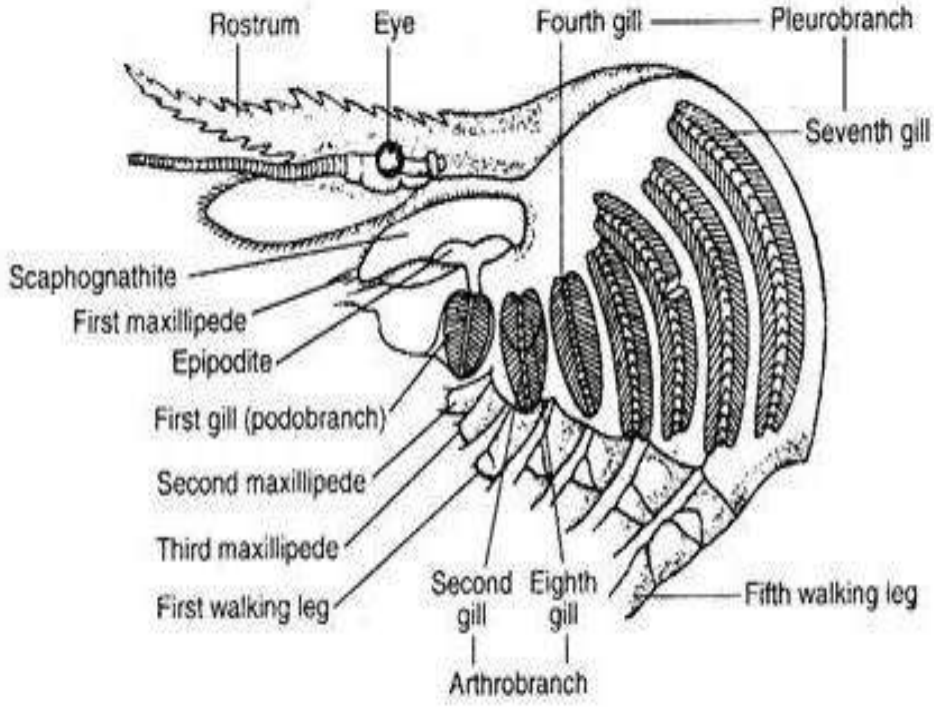
- **1. Gills or Branchiae: Examples:** Crustaceans (*Palaemon* sp., *Penaeus* sp.).
- **2. Tracheal gills: Ex.:** May fly nymph, Damsel fly nymph.
- **3. Blood gills: Ex.:** Blood worm (*Chironomus* larva), black fly larva (*Simulium* larva).
- **4. Rectal gills: Ex.:** Dragon fly nymph.
- **5. Book gills: Ex.:** Horseshoe crab (*Limulus* sp.).
- **6. Plastron: Ex.:** Riffle beetles, water boatman (*Notonecta* sp.) etc.
- **7. Air bubble: Ex.:** Diving beetle (*Rhantus* sp.), water spiders (*Argyroneta* sp.).
- **8. Breathing tube: Ex.:** Water scorpion (*Nepa* sp.), mosquito larvae (*Culex* sp.).
- **9. Cutaneous respiration: Ex.:** *Chironomus* larva.
- **10. Lining of Branchiostegites: Ex.:** Inner lining of crustacean gill cover.
- **11. Epipodites: Ex.:** Coxal segment of maxillipeds in prawn.

2. AERIAL RESPIRATION (absorb oxygen from air):

- **1. Trachea: Ex.:** Insects, centipedes, millipedes, arachnids.
- **2. Lungs: Ex.:** Terrestrial hermit crabs (*Birgus* sp., *Coenobita* sp.).
- **3. Book-lungs: Ex.:** Spiders and scorpions.
- **4. Pseudotracheae or lungs: Ex.:** wood lice (*Oniscus* sp.).

❖ DEVICES OF AQUATIC RESPIRATION:

❑ 1. GILLS OR BRANCHIAE: Aquatic mode of respiration.



Respiratory organs (Gills) of *Palaemon*. Note that the branchiostegite of one side has been removed to expose the gill-chamber.

➢ (I) OCCURRENCE:

- In aquatic arthropods. Best developed in **crustaceans**.
- In some forms, special types of gills are often found.

➢ (II) LOCATION:

- The Gills are located within the gill chamber.
- The gill chamber is situated on each lateral side of the cephalothorax.
- The gill chamber is covered by the branchiostegite or carapace.

➢ (III) ORIGIN :

- Gill develops as the outpushings of the body wall.
- Gills are the outgrowths of the thoracic limbs in **Amphipods**.
- Endopodites of the 2nd and 5th pleapods are modified as gills in **Isopods**.

➢ (IV) STRUCTURE of a typical gill in crustacea (*Palaemon* sp):

A typical gill is crescent-shaped.

✓ 1. Central axis:

- Gill contains a central axis or rod.
- It consists central core of connective tissue.

✓ 2. Gill lamellae (gill plates/gill filaments):

- A gill consists of 2 rows of thin gill lamellae.
- A lamella contain single layer of cells.
- The gill lamella is covered by cuticle.
- Lamellae are arranged on each side of the central axis.

✓ 3. Lamella base:

- One end of each lamella is attached with the central axis.

✓ 4. Branchial blood channels:

- Two lateral longitudinal channels and 1 median longitudinal channel runs through the central axis.
- A marginal blood channel runs through the lamella.

✓ 5. Gill-root:

- Each gill is attached to the thoracic wall by a small connection called gill root.

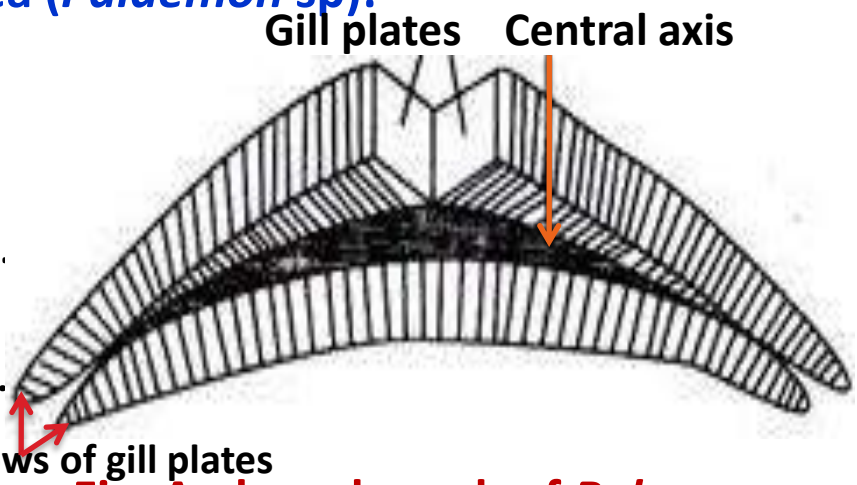


Fig: A pleurobranch of *Palaemon* sp.

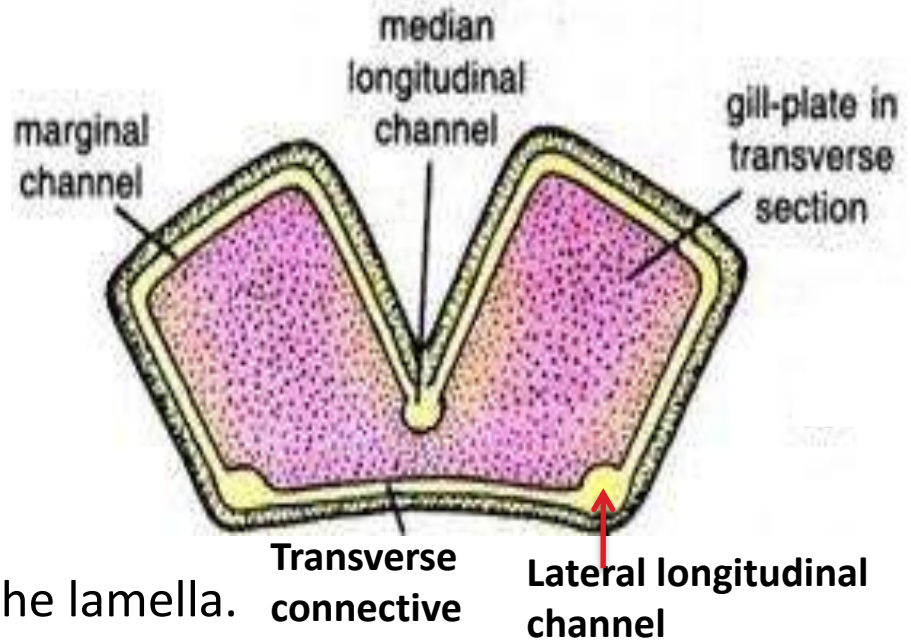


Fig: Gill-plate of *Palaemon* sp.

✓ **6. Gill chamber:**

- Gills are located within a gill chamber in Decapoda crustaceans.
- Gill chamber is covered by a carapace.
- In most crustacean, gills are not housed within the gill chamber.

➢ **(V) MECHANISM of the gill respiration:**

- **Formation of water-current in the gill chamber:**

  The vibration of scaphognathite causes constant water-current.

- **Entry of water-current in to gill chamber:**

  Water enters the gill chamber along the postero-ventral margins of the carapace.

- **Course of water-current inside the gill chamber:**

  Water flows over the gills, epipodites and antero-dorsal depression of gill chamber.

- **Exit of water current from gill chamber:**

  Water expelled out at the anterior end of the gill chamber.

- **Types of respiratory surfaces:**

  Highly vascularized surfaces of gill plates, epipodites and branchiostegites.

- **Respiratory gas exchange:**

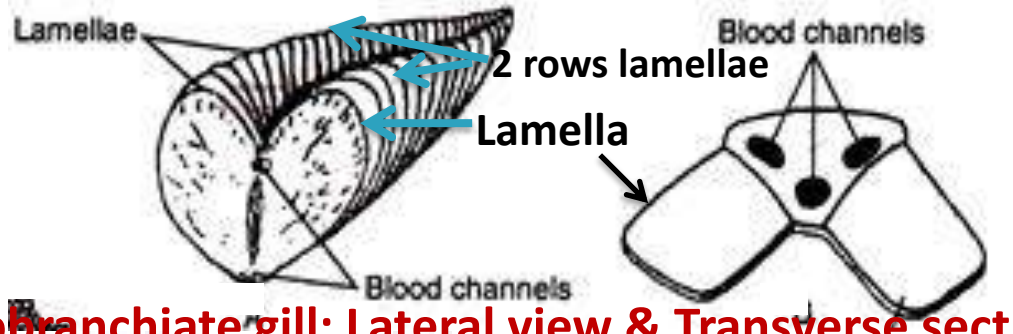
  The oxygen of the water diffuses into the blood and carbon dioxide diffuses into the water current.

➢ (VI) TYPES of the gills in Crustacea:

❖ A. Based on the shape of the lamellae, the gills are of 3 types:

✓ 1.Phyllobranchiate gill:

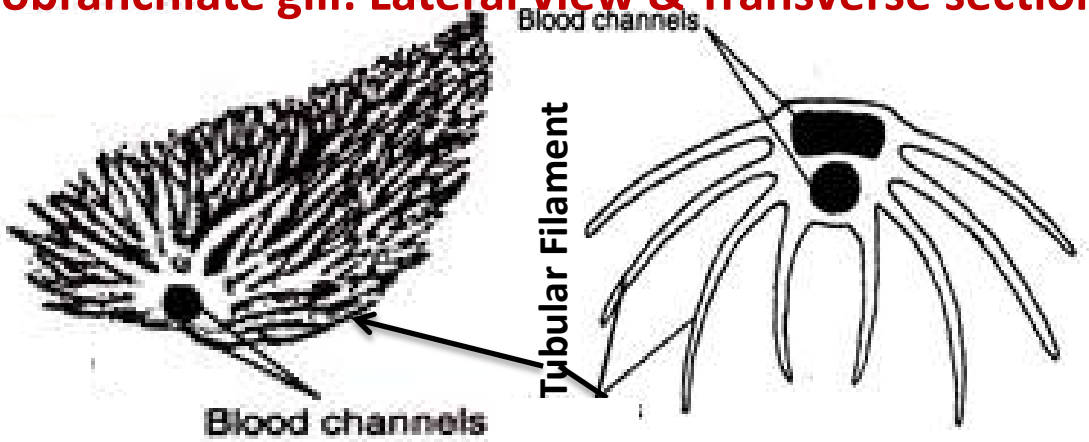
- The lamellae of the gills are flat, broad leaf-like and are arranged in two rows.
- Found in crab and prawn (*Palaemon* sp.).



Phyllobranchiate gill: Lateral view & Transverse section

✓ 2.Trichobranchiate gill:

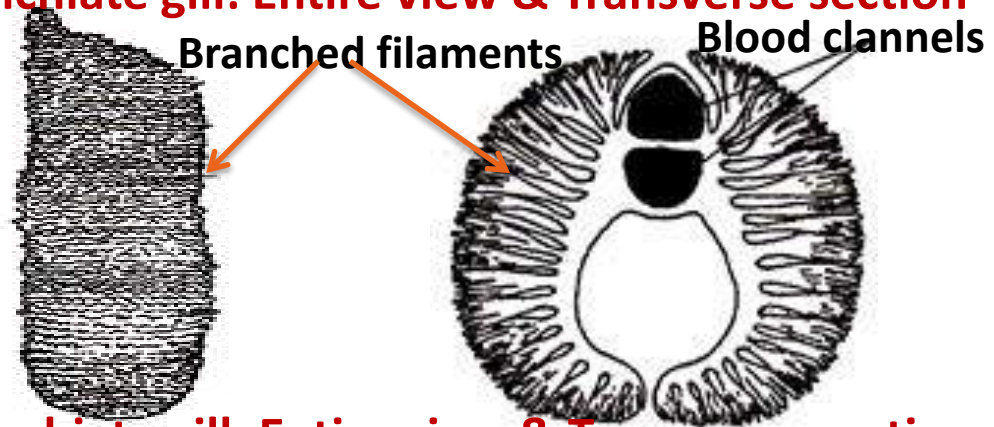
- The gill filaments are tubular.
- Consists of a central axis with numerous lateral filaments.
- Found in crayfish (*Astacus* sp.), rock lobster etc.



Trichobranchiate gill: Entire view & Transverse section

✓ 3.Dendrobranchiate gill:

- The leaf-like lamellae are divided into fine branched filaments.
- Found in *Penaeus* sp.



Dendrobranchiate gill: Entire view & Transverse section

❖ **B. Based on the mode of attachment, gills are of 3 types:**

✓ **1. Podobranch or foot gill:**

- Podobranchs are attached with the **coxopodite** of the thoracic appendage.
- In ***Palaemon* sp.**, the **1** podobranch attached to the 2nd maxillipede.
- In ***Penaeus* sp.** the **1 pair** podobranch attached to the 2nd pair of maxillipedes.

✓ **2. Arthrobranch or joint gill:**

- Arthrobranchs are attached with the **arthroidal membrane** of the thoracic appendage.
- In ***Palaemon* sp.**, **2** arthrobranchs attached to the arthroidal membrane of 3rd maxillipede.
- In ***Penaeus* sp.**, **11 pairs** arthrobranchs attached from 2nd maxillipede to 3rd walking legs and a single arthrobranch attached with 4th walking leg.

✓ **3. Pleurobranch or side gill or wall gill:**

- Pleurobranchs are attached with the **lateral side of the thoracic segment** having the limb.
- In ***Palaemon* sp.**, **5** pleurobranchs attached to the lateral side of the thoracic segments bearing 5 walking legs.
- In ***Penaeus* sp.**, **6 pairs** of pleurobranchs attached tothe last 6 pairs of thoracic appendages.

➢ Branchial formula of Prawn (*Palaemon* sp.)

Appendages	Podobranchs	Arthrobranchs	Pleurobranchs	Epipodites	Total
I Maxilliped	—	—	—	1	1
II Maxilliped	1	—	—	1	2
III Maxilliped	—	2	—	1	3
I Walking leg	—	—	1	—	1
II Walking leg	—	—	1	--	1
III Walking leg	—	—	1	—	1
IV Walking leg	—	—	1	—	1
V Walking leg	—	—	1	—	1
Total	1	2	5	3	11

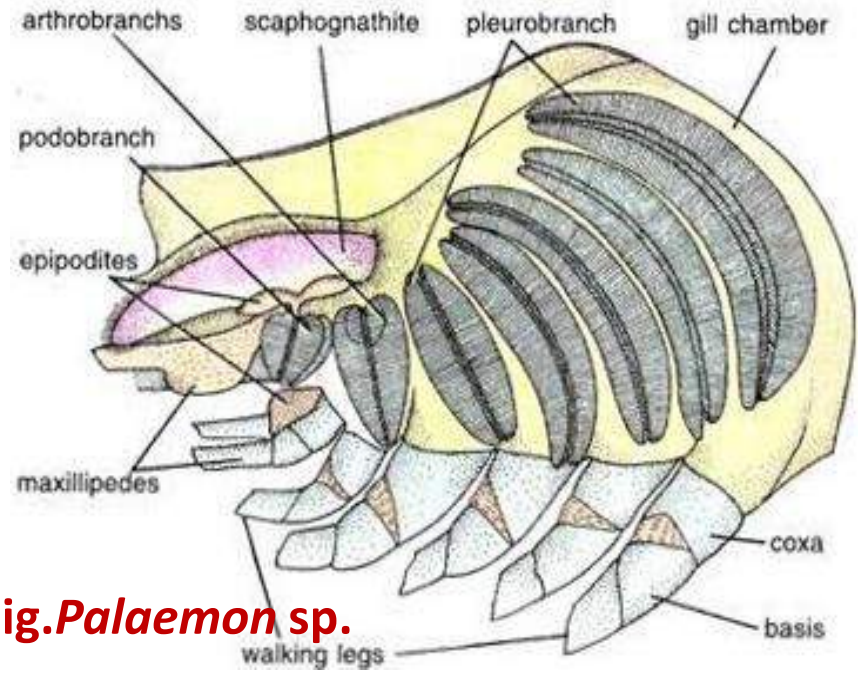


Fig.*Palaemon* sp.

➢ Branchial formula of Prawn (*Penaeus* sp.)

Type of branchiae on one side of the thorax	Thoracic segment								Total
	I	II	III	IV	V	VI	VII	VIII	
Podobranchiae	0	1	0	0	0	0	0	0	1
Arthrobranchiae	0	2	2	2	2	2	1	0	11
Pleurobranchiae	0	0	1	1	1	1	1	1	6
Epipodites	1	1	1	1	1	1	0	0	6
Total	1	4	4	4	4	4	2	1	24

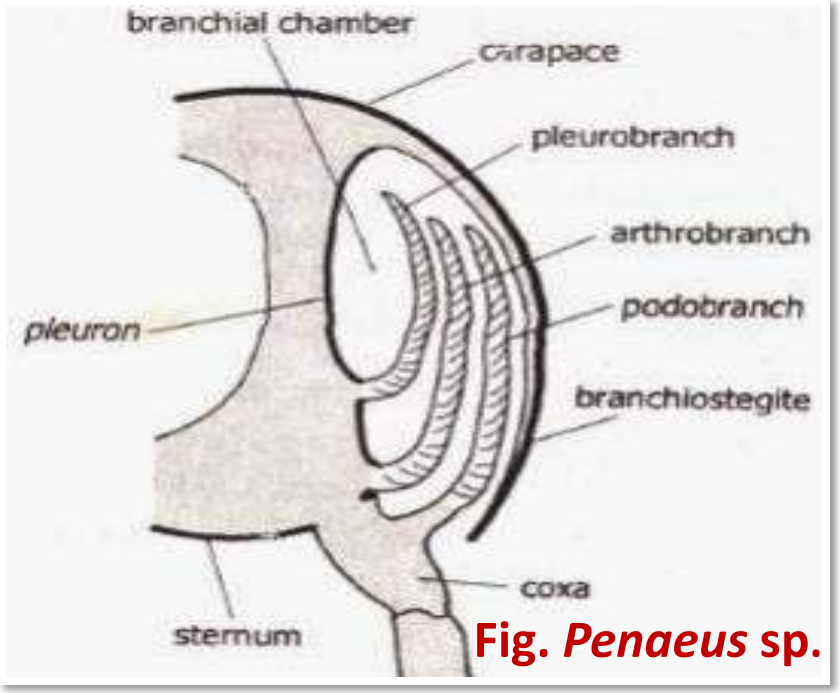
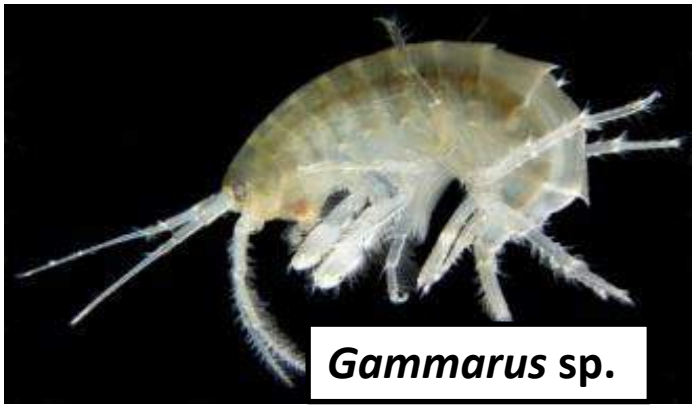


Fig. *Penaeus* sp.

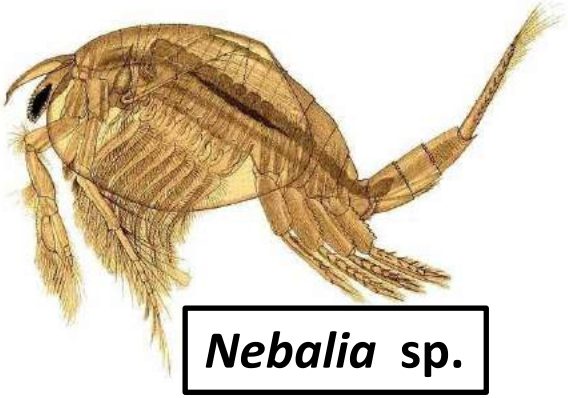
(VII) MODIFICATION of the gills in aquatic Arthropoda:

- ❖ Crustacean gills are variously modified.
- ➢ Gills are broad **epipodites** of the thoracic appendages, e.g. *Nebalia* sp. (Class: Malacostraca).
- ➢ Gills are **plate-like**, e.g. *Gammarus* sp. (Class: Malacostraca).
- ➢ Gills are **flattened**, e.g. *Palinurus* sp. (Class: Malacostraca).
- ➢ Gills are **tufted podobranchs**, with no carapace, e.g. krill (Class: Malacostraca).
- ➢ Gills are the row of small **branchial lamellae**, e.g. *Stenocypris* sp. (Class: Ostracoda).
- ➢ Gills are **leaf-like pleopods**, e.g. *Triops* sp. (Class: Branchiopoda).
- ➢ Gills are **abdominal** in position, e.g. *Squilla* sp. (Class: Malacostraca).

CRUSTACEAN: The aquatic Arthropoda.

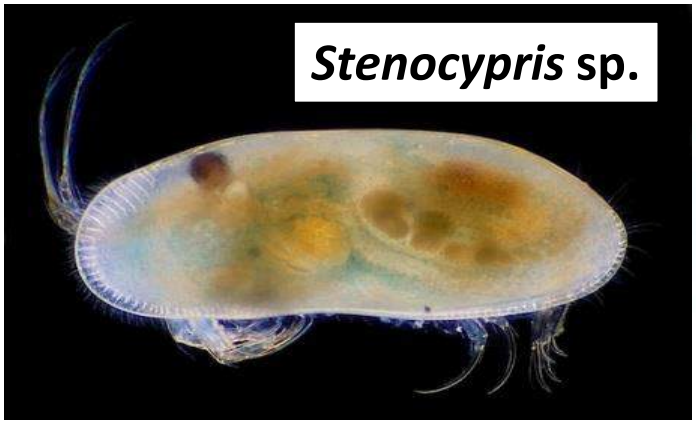


Gammarus sp.

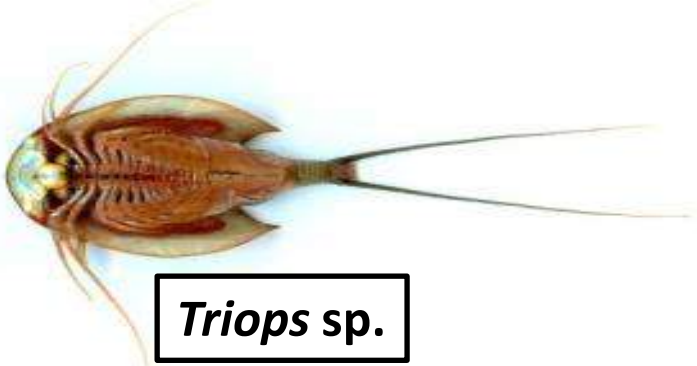


Nebalia sp.

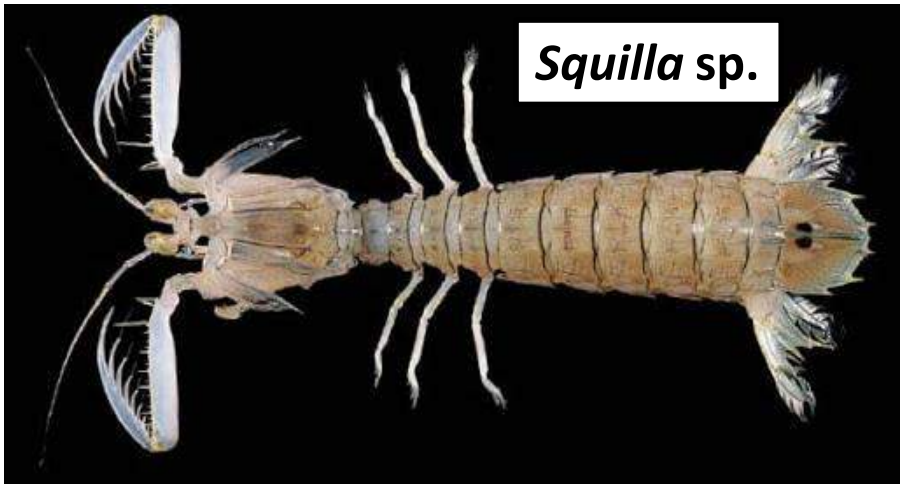
Palinurus sp.



Stenocypris sp.



Triops sp.



Squilla sp.

Krill

❑ 2. TRACHEAL GILLS: (Gill like structure)

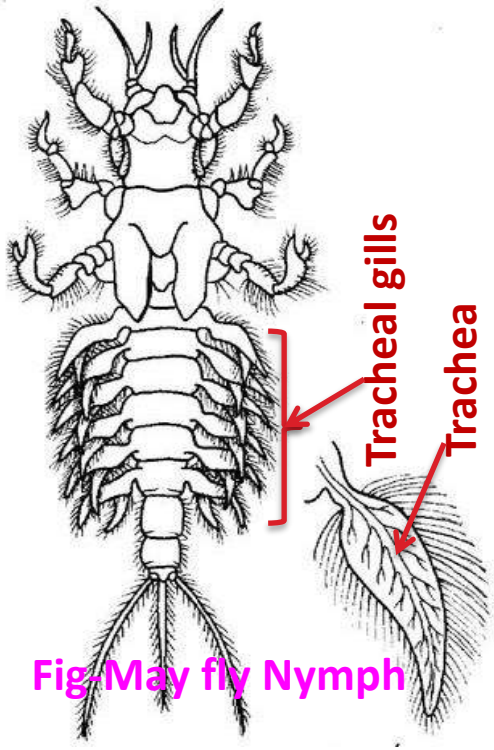


Fig-May fly Nymph

✓ Occurrence:

- Developed in many aquatic insect larvae and nymphs.
- Lamellate (leaf like) tracheal gill in May fly nymph and Damsel fly nymph.
- Filamentous tracheal gill in stone fly and caddis fly larvae.

✓ Structure:

- A network of tracheoles covered by a very thin cuticle.
- It is composed of a series of simple, divided and thin external integumental evaginations.
- They are called plates or filaments covered by a very thin cuticle.
- The filaments are richly supplied with tracheae and very small blood cavities.
- They are attached to the wall of the abdominal or thoracic segments.

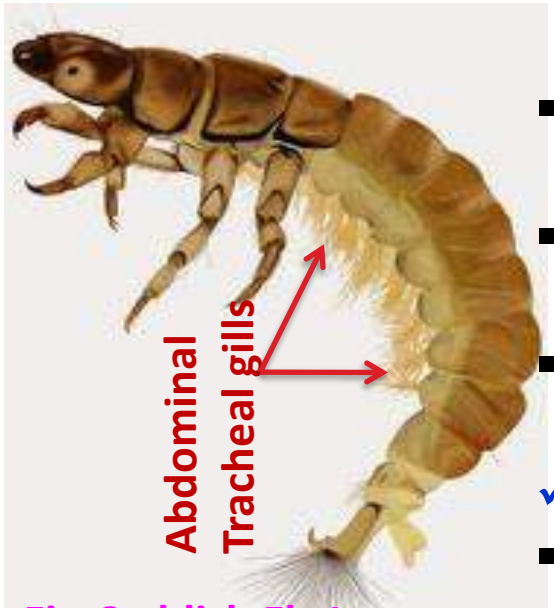


Fig-Caddish Fly Larva

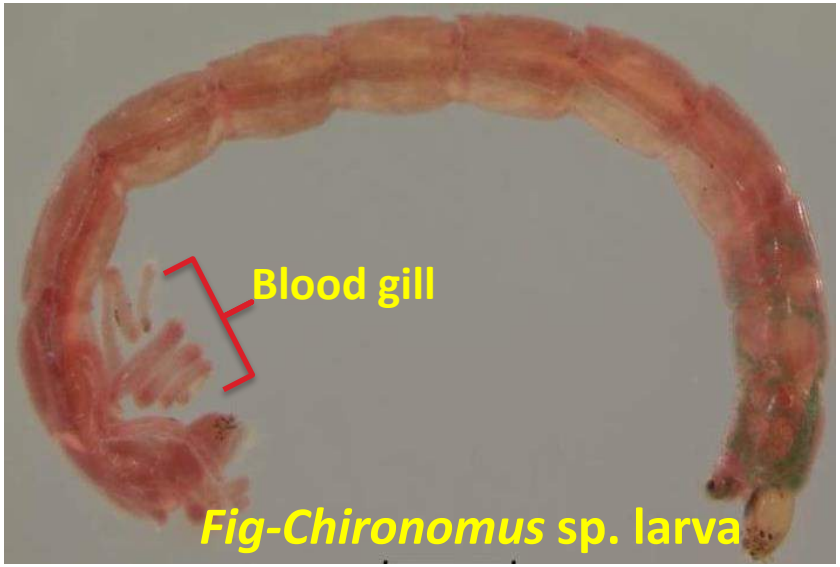
✓ Function:

- Diffusion of dissolved O_2 from the water into the body

3. BLOOD GILLS: Gill like structure with no tracheal system.

➢ Occurrence:

- In certain insect larvae of Diptera and Trichoptera.
- Ventral & anal gills of blood worm (Diptera).
- Anal gill of black fly larvae (Diptera)

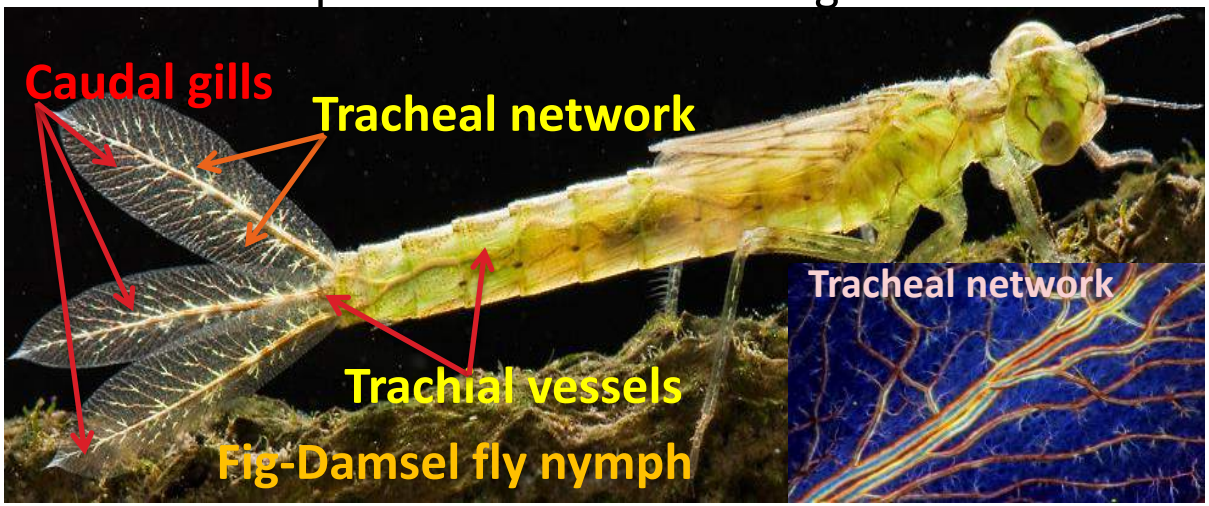


➢ Structure:

- They are thin walled fimbriated blood filled evaginations of integument.
- Tracheae are very poorly developed or totally absent.

➢ Function:

- i. The absorption of water and inorganic ions. ii. No value as organs of respiration.



➢ CAUDAL GILL:

- Found in Damselfly nymphs.
- Located at abdominal end.
- Three gills are tracheated.
- Absorb O_2 from the water and carry to the tissues.

4. RECTAL GILLS: Breathing through anus.

Occurrence:

- The nymphs of several aquatic insects (Order:Odonata).
- Dragon fly nymph bears rectal gills.
- Rectum of dragon fly nymph is modified into a **branchial basket**.

Structure:

- Gills are located in the inner lining of the rectum.
- Rectal wall is richly supplied with tracheal network.
- The rectal wall is contractile.
- The contractions of abdominal muscles maintains water circulation within rectum

Function:

- Aquatic respiration in oxygen deficient habitat.
- Doubles the water-jet propulsion mechanism for escaping predator.

Fig.-Dragon fly nyaph

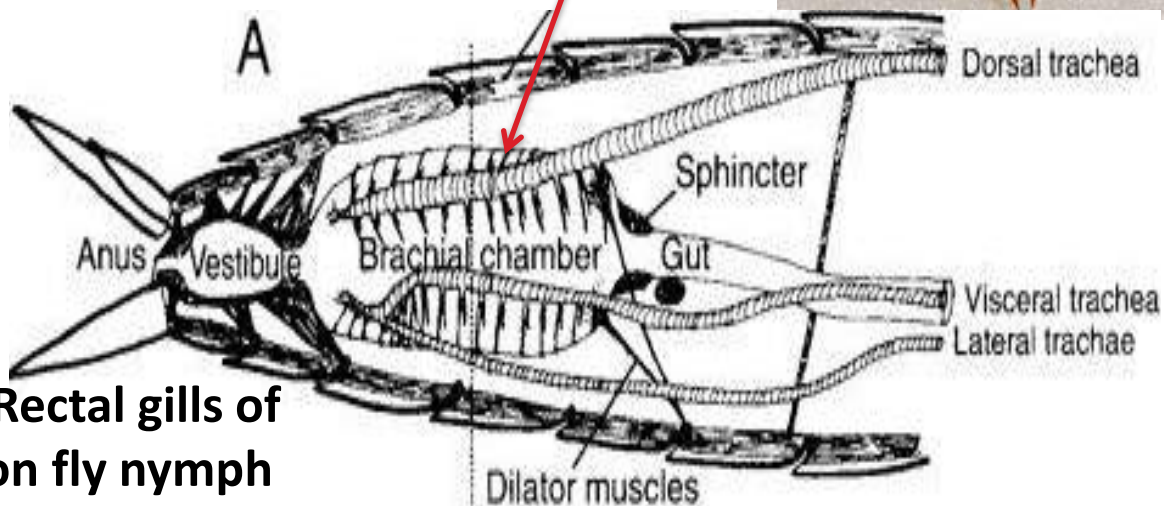


Fig.- Rectal gills of dragon fly nymph

5. BOOK GILLS:

✓ Occurrence:

- Book gills (5 pairs) are found in marine arthropod *Limulus* sp. (Horseshoe crabs).

✓ Structure:

- They are the flap-like appendages.
- Associated with 9th to 13th abdominal segments.
- Formed by the evagination of the posterior borders of the opisthosomal appendages.
- Each gill contains nearly 150 lamellae.
- Lamellae are vascularized, thin & membranous
- Lamellae are arranged like the leaves of a book.
- Movement of appendages drives blood circulation the lamellae & water circulation over the lamellae

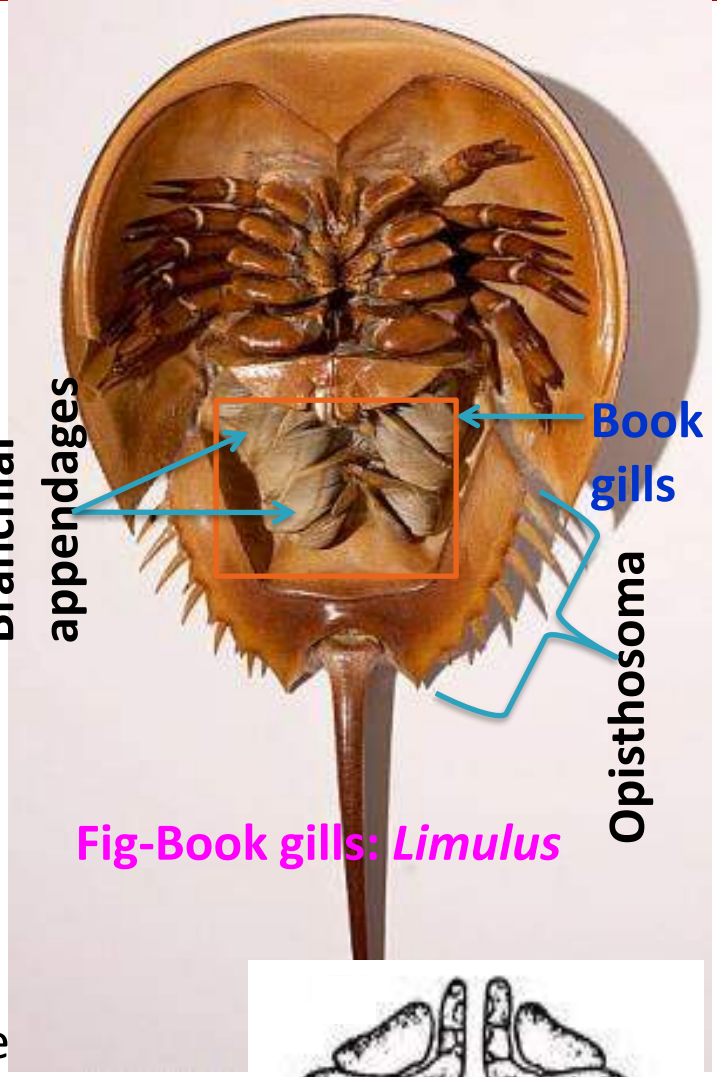
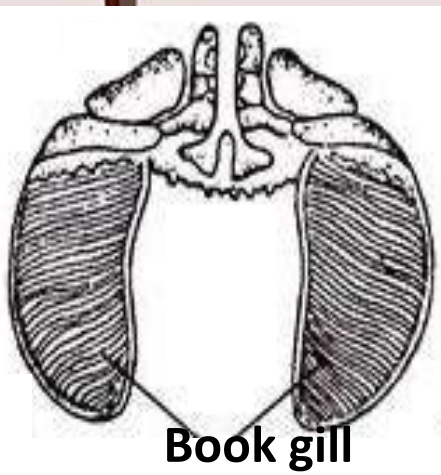


Fig-Book gills: *Limulus*



✓ Function:

- Lamellae of the gills helps in gas exchange in aquatic habitat.
- They helps in osmoregulation.

❑ 6. PLASTRON: Air film trapped within a plastron operates as a physical gill.

✓ Occurrence:

- Submerged arthropods, like diving insects (Riffle beetles, water boatman etc.)

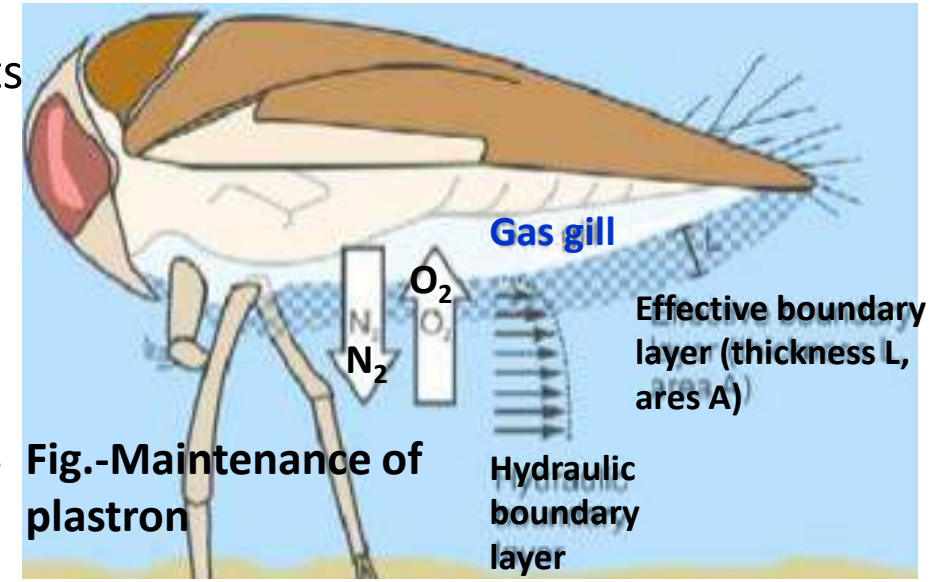


Fig.-Maintenance of plastron

✓ Structure:

- Plastron is a very thin layer of air held firmly in place by tiny hydrofuge hairs.
- Air is held in a series of cuticular grooves by hydrofuge hairs.
- The spiracles open directly to the thin layer of air.
- Hydrofuge hairs are water-repellent wax coated, epicuticular structures on the body of aquatic insects.

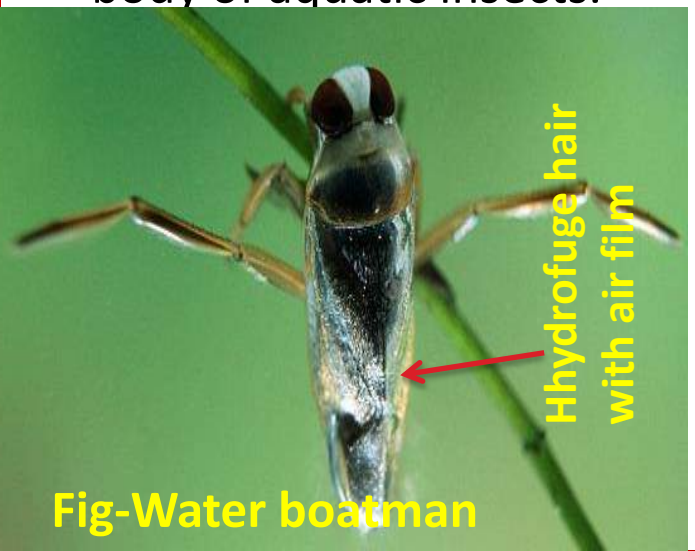


Fig-Water boatman

✓ Functional mechanism:

- Plastron is actually a modified air storage chamber.
- The partial pressure deficit is created as the insect consume O_2 from the plastron.
- The pressure deficit is corrected by the diffusion of dissolved O_2 into the plastron.
- The volume of the air does not change.

❑ 7. AIR BUBBLES: (“physical gill”) Bubble breathing.

✓ Occurrence:

- In some aquatic insects, for example diving beetles.

✓ Functional mechanism:

- During the diving beneath the water-surface insects carry air bubbles under their wing covers (elytra).

Fig-Cross-section showing the air store

- At submerged condition the bubbles supply air to the spiracles.
- They protects the spiracles from the water.
- The O_2 of the bubble can be refilled by the diffusion from the water.
- They provides short-term oxygen supply.
- Insect must return to the water-surface when the bubble becomes too small.

❑ 8. BREATHING TUBE: (Respiratory Siphon)

✓ Occurrence:

- i) Some underwater insects get O_2 by inserting the siphon tubes into the aerenchyma tissues of aquatic plants.

  Ex.:- *Mansonia & Coquillettidia* (Mosquito larvae) (mosquitoes).

- ii) Many under water insects get air from the atmosphere through siphon tubes.

  Ex.:- Mosquito larvae, water scorpions (*Nepa* sp.), rat-tailed maggots (syrphid fly larvae).

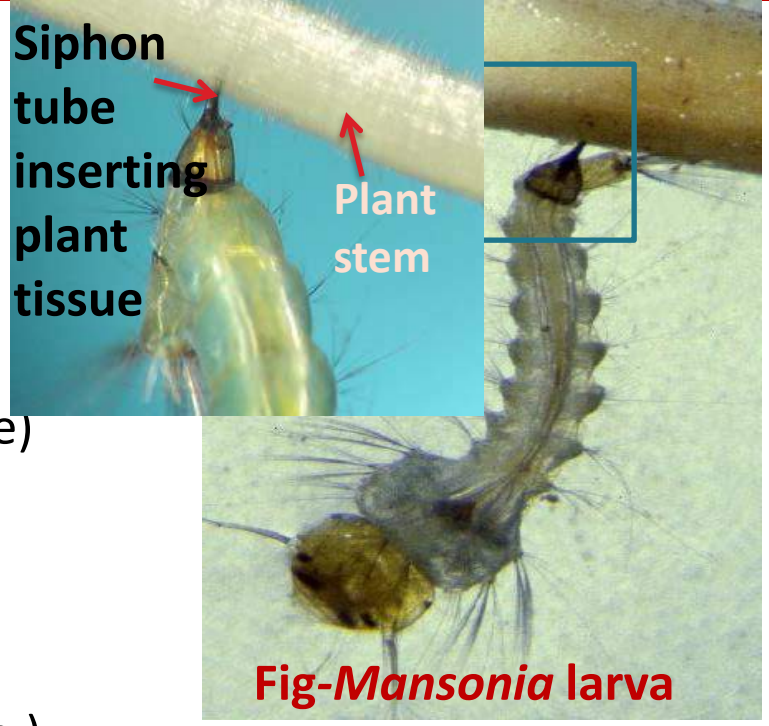


Fig-*Mansonia* larva

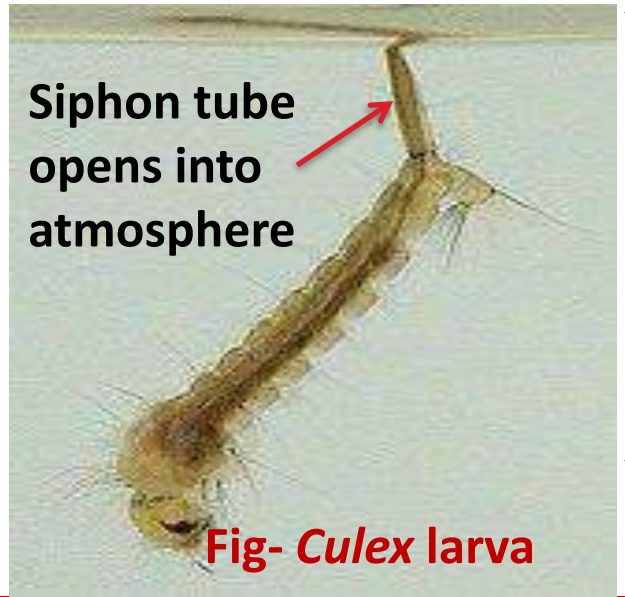


Fig- *Culex* larva

✓Structure:

- Siphon tube is an extension of the posterior spiracles.
- Opening end of the siphon is guarded by a ring of hairs with a waterproof coating.
- The ring of hairs break the surface tension and keep an open airway.
- When insect dives, hairs closes the siphon-opening.

✓Function:

- Helps in aerial breathing in aquatic condition.

9. CUTANEOUS RESPIRATION:

- The integument is very thin over the gill-like structure (tracheal gill, anal gill etc.)
- They assists simple **diffusion of respiratory gases**.
- **Example:** In many aquatic insects the surfaces of the.

10. LINING OF BRANCHIOSTEGITES:

- The lateral extension of carapace is called gill cover branchiostegite.
- Inner lining of the branchiostegite is thin, membranous & richly vascularized.
- The vascularized lining is in direct contact with fresh water current.
- It acts as a surface of **respiratory gas exchange**.
- **Example:** In some crustaceans (e.g. *Palaemon* sp.).

11. EPIPODITES:

- Epipodites (3 pairs in *Palaemon*) are located in the anterior part of each gill-chamber.
- They are the evaginations of integument of coxae of the maxillipedes.
- They are thin, leaflike, membranous and highly vascularized.
- They are in contact with fresh water.
- The vascularized surfaces are **respiratory in function**.
- **Example:** In some crustaceans (e.g. *Palaemon* sp.).

❖ **A SHORT SUMMARY: Respiration in aquatic insects.**

➢ **1. Closed tracheal system:--**

- In some aquatic and many endoparasitic larvae spiracles are absent.
- The tracheal network beneath the integument allow gas exchange.

✓ **Gills like structures:**

- They are tracheated thin outgrowth of the body wall with no spiracles.
- **Tracheal gill**—May fly nymph (lamellate gills), Damsel fly nymph (filamentous gills).
- **Rectal gills**—Dragon fly nymph.
- **Blood gill**—Blood worm (*Chironomus* larvae).
- **Anal gills**— Crane fly larva.

➢ **2. Open tracheal system:--**

- In some aquatic air-breathing insects, tracheal system opens through the special structures.

✓ **Special structures:**

- They provide air for air-breathing aquatic insects.
- **Respiratory siphon** — Mosquito larvae.
- **Breathing tube** — Water scorpion.
- **Air bubble** — Diving beetles.
- **Plastron** — Riffle beetles.

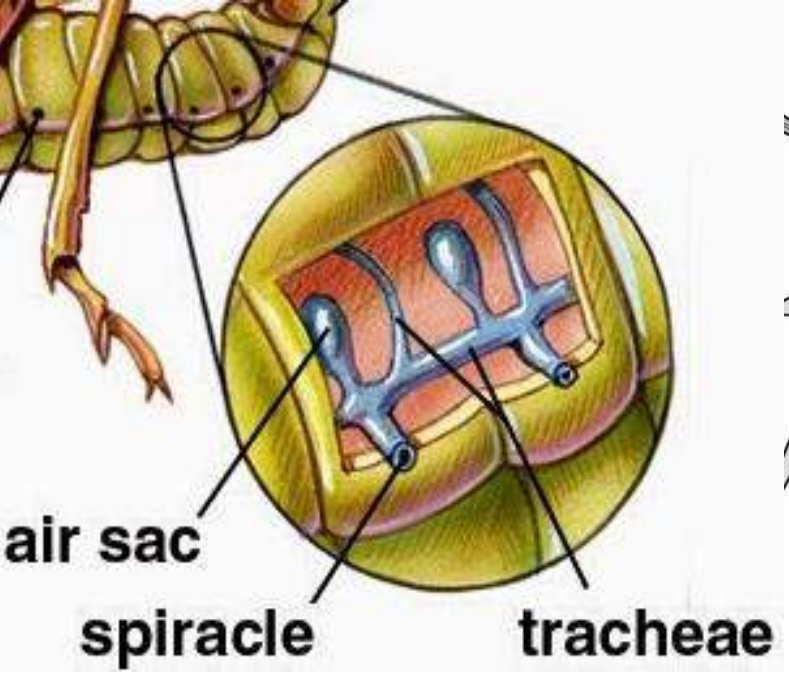
❖ DEVICES OF AERIAL RESPIRATION:

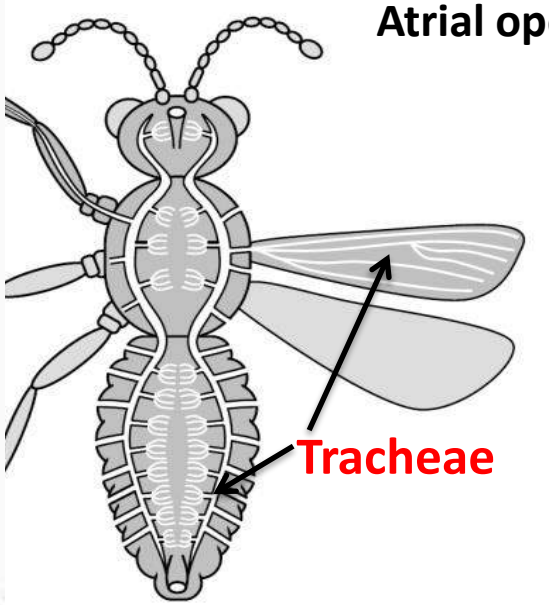
❑ 1. TRACHEA :--

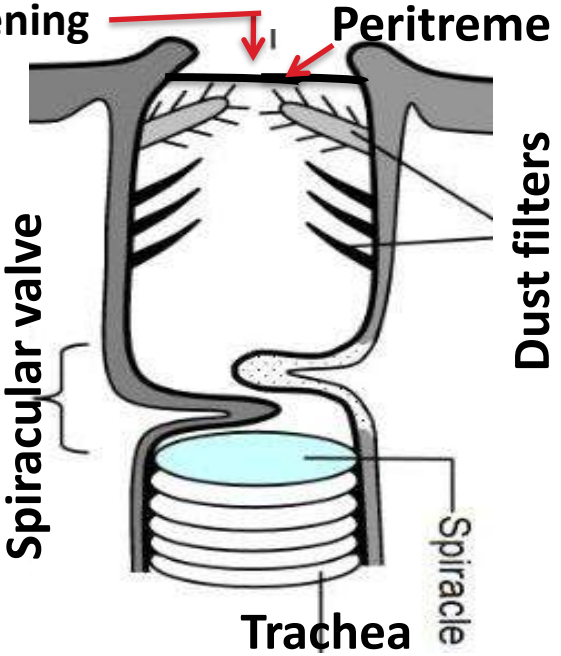
The chitin-lined tubular organ of aerial respiration.

- **Occurrance**: Almost all land living arthropods like insects, centipedes, millipedes and many arachnids.
- **Types** : There are 2 types of trachae---
  - **i. Ventilation trachea:** Collapses after the exhalation of air.
  - **ii. Diffused trachea:** Rigid, after the exhalation does not collapse.
- **Origin:** The tracheae originate as the invagination of the ectoderm.
- **Structure:** The basic insect-respiratory system consists of----
  - (i) **Cells of tracheal tube:** The tube-walls are made up of polygonal cells.
  - (ii) **Layer of tubular wall:** a. **intima** (inner lining) b. **epithelial cells** (middle) and c. basal lamina (external).
  - (iii) **Taenidea:** Spiral cuticular ridges of tracheal intima. Prevents tracheal collapse.
  - (iv) **Tracheal cuticle:** Like surface cuticle but without the cement & wax layer.
  - (v) **Spiracle or stigmata:** The external small opening of the tracheae.
  - (vi) **Location of spiracles:** Along the sides of the body.

- (vii) **Atrium**: A chamber where spiracle opens.
- (viii) **Peritreme:** A plate of small, distinct sclerite on which the spiracle is placed.
- (ix) **Spiracular lids**: Two lids for opening and closing.
- (x) **Peristigmatic glands**: Secretion prevents wetting of the spiracles .
- (xi) **Filtering apparatus:** Composed of bundles of setae or a sieve-like membrane. Eliminate foreign particles and located within the chamber.
- (xii**) Air-sacs:** Thin walled-collapsable dilated parts of tracheae. Acts as air reservoirs, sound resonator and heat insulators.
- (xiii) **Tracheoles:** Fine (diameter:1µ), blind ended branches of tracheae with no taenidea. Reaches every respiring cells for gaseous exchange.
- (xiv) **Tracheoler end-fluid:** At rest it is filled with fluid. Serve to reduce water-loss.
- (xv) **Tracheolar cell:** Tracheal end cell that forms and encloses the tracheoles.







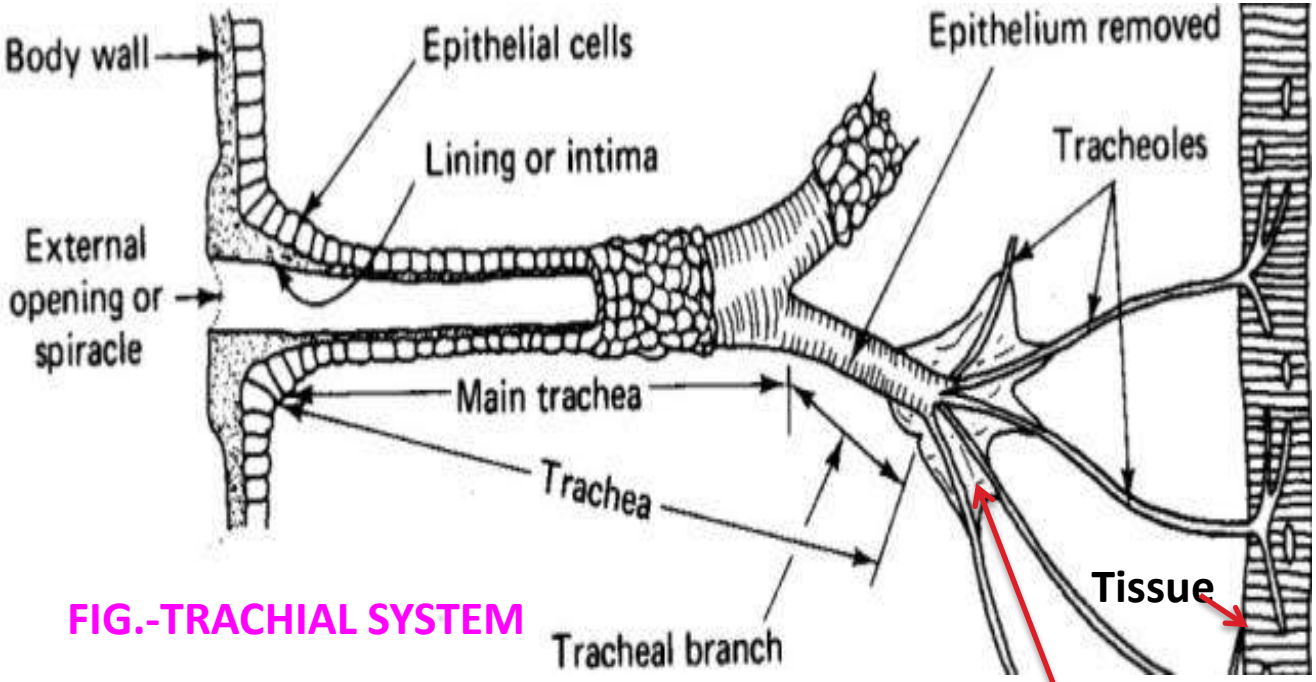


FIG.-TRACHIAL SYSTEM

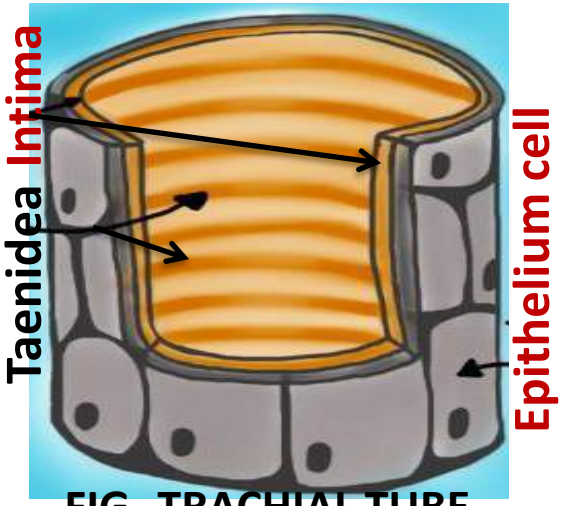


FIG.-TRACHIAL TUBE

➢ **Classification of the tracheal system: On the basis of the number and distribution of the functional spiracles:-**

✓ **(i) Polypneustic:** 8 or more pairs of **functional spiracles**.

Subdivisions of the polypneustic trecheal system:

- **Holopneustic:** 2 pairs thoracic, 8 pairs abdominal spiracles

  Ex.: dragonflies grasshoppers, cockroaches, fleas.
- **Peripneustic:** 1 pair thoracic, 8 pairs abdominal spiracles.

  Ex.: caterpillars and many endopterygote larvae.
- **Hemipneustic:** 1 pair thoracic, 7 pairs abdominal spiracles

✓ **(ii) Oligopneustic:** 1 or 2 pairs of **functional spiracles**.

Subdivisions of the oligopneustic trecheal system:

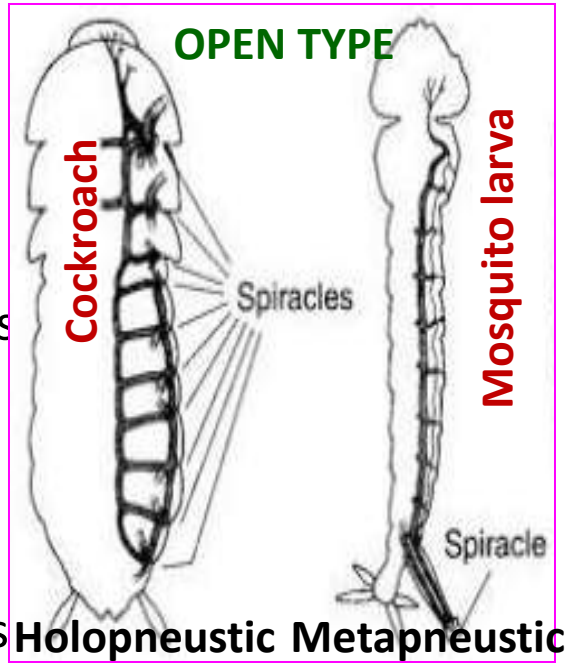
- **Amphipneustic:** 1 pair thoracic, 1 pair post-abdominal spiracles. **Ex.**: House fly larva.
- **Metapneustic:**1 pair post abdominal spiracles present.

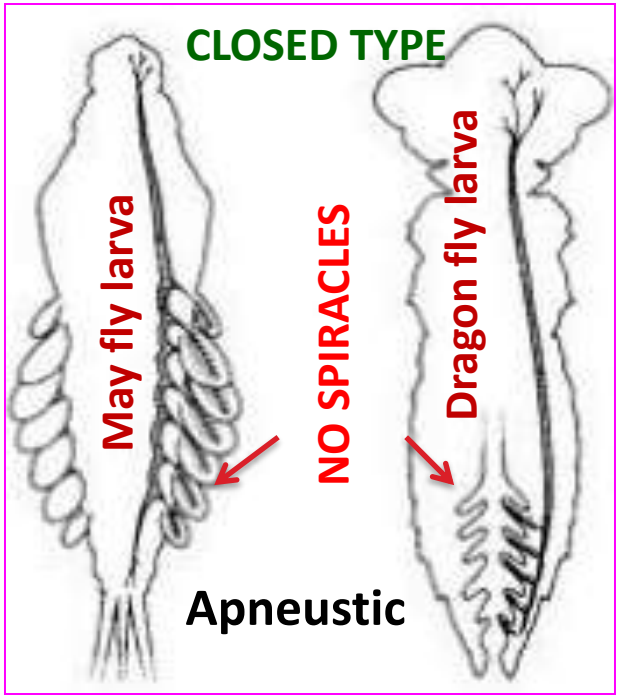
  Ex.: Mosquito larva.
- **Propneustic: 1** pair thoracic spiracles is functional.

  Ex.: some pupae of Diptera.

✓ **(iii) Apneustic: No functional spiracle**.

Ex.: Aquatic insect larvae





➢ Mechanism of tracheal respiration:

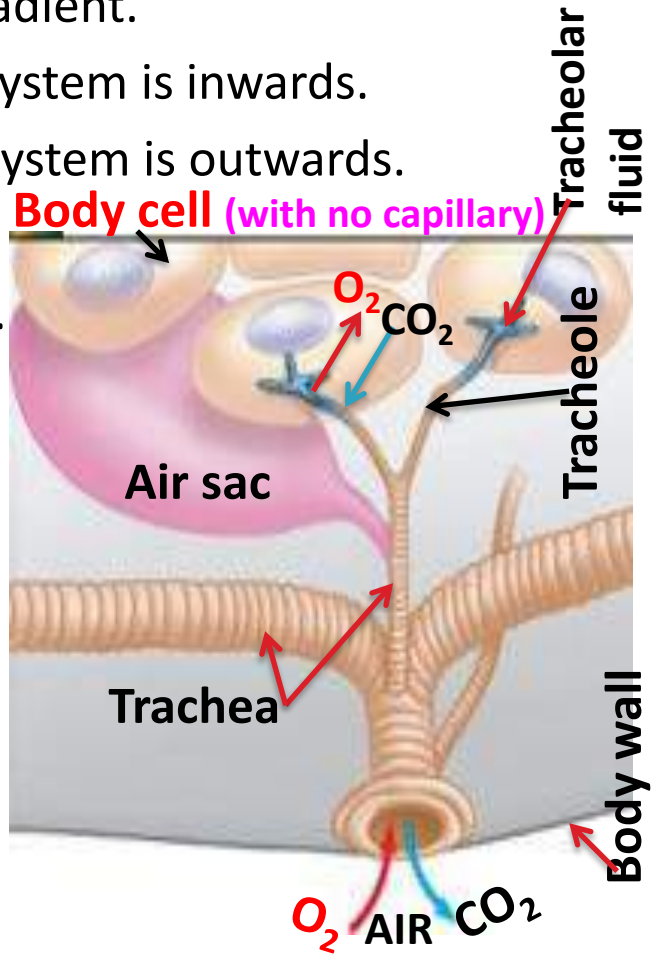
- The tracheal respiration involves **ventilation** and **diffusion** of gases.

✓ **1. Ventilation (air tube transport): C**onvective movements of gases through the tracheal system.

- Air enters the spiracle and passes through the length of the tracheae to the tracheoles and into the target cells.
- The respiratory gases moves along a concentration gradient.
- Inspiration : The net movement of O_2 in the tracheal system is inwards.
- Expiration: The net movement of CO_2 in the tracheal system is outwards.

✓ **2. Diffusion (tissue diffusion):**

- Networks of tracheoles are the major site of diffusion.
- O_2 diffuses into the tissues from the tracheal lumen.
- CO_2 diffuses out from tissue to the tracheal lumen.
- Fluid in the tracheolar ends regulates the volume of air that contacts with the cells.
- At rest, the tracheolar ends are filled with a fluid.
- During cellular activity the fluid pulls back, exposes the cell membrane to the air.
- The tracheolar fluid is absorbed during respiration.



Factors responsible for respiratory movement:

- **Alternate contraction and expansion of the body:** Air is drawn in and forced out through the spiracles.
- **Reduction of hemocoelomic pressure:** Responsible for brief-opening of spiracles.
- **Spiracle-valves: C**ontrols water loss.
- **High CO_2 concentration:** Regulate the opening of the spiracles.
- **Temperature:** At low temperatures, the spiracles are closed but open occasionally. At higher temperatures open and close periodically.

Functions of trachea:

- **i.** Provide O_2 to the tissues, eliminate CO_2 **ii.** Act as connective tissue. **iii.** Maintain body temperature. **iv.** Sound production.

Modifications of the tracheae:

- **Absence of tracheae:** Found in *Collembola* sp., respiration is cutaneous.
- **Single spiracle connected to the dorsal trunk:** Found in mosquito larvae.
- **Spiracle open into air chamber:** Found in the Subphylum Myriapoda**.**
- **Spiracle with sieve plate:** Found in dipterans, coleopterans and lepidopterans.
- **Branched tracheae:** Found in the Class Diplopoda (Millipedes).
- **Head with only 2 tracheae:** Found in the Class Symphyla (Garden centipedes)

❑ 2. LUNGS: Modified branchial chamber for the aerial gas exchange.

➢ Occurrence:

- Terrestrial hermit crabs (Crustacea)
  Birgus sp., *Coenobita* sp.

➢ Type & Structure:

✓ **i. Branchiostegal lungs (*Birgus* sp.):**

- The branchial chambers are highly enlarged.
- The upper part of the branchial chamber form a separate chamber.
- Inner lining of the branchial chamber forms numerous vascular projections.

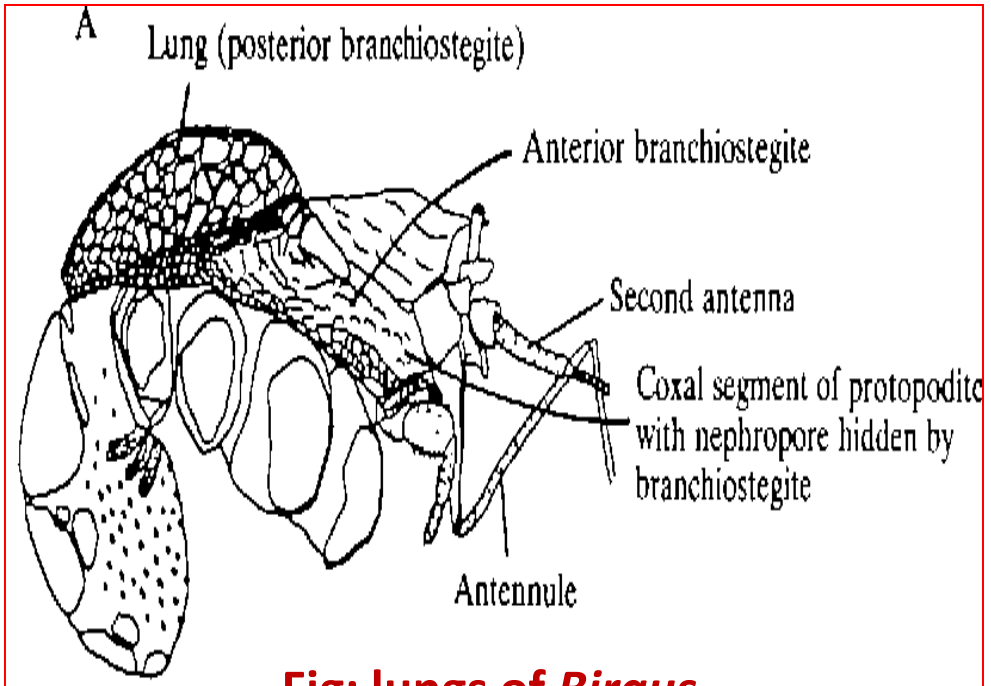


Fig: lungs of *Birgus*

- The tufts of vascular projections helps in respiration.
- The changes in volume of the branchial chamber maintains its air flow.

✓ **ii. Abdominal lungs (*Coenobita* sp.):**

Developed from the highly vascularized, very thin and intensely folded dorsal integument.

➢ Function:

- Perform aerial respiration.

❑ 3. BOOK-LUNGS:

➢ **Occurrence:** Main respiratory organ of spiders & scorpions.

➢ **Structure :Typical book–lung of the Scorpion.**

- They are the modified abdominal appendages.
- They are blind sac-like cavity.
- Formed by the invagination of the body wall.
- Inner lining of the sac contain numerous folds.
- Lamellae (folds) are like the leaves of a book.
- Outer side of the lamellae contain ridges & bristles.
- It opens to the exterior by a stigma.
- The cavity is divided into **2 chambers:-**

✓ **i. Atrial chamber:** A proximal, smaller chamber.

- It's roof is perforated by slit-like openings.

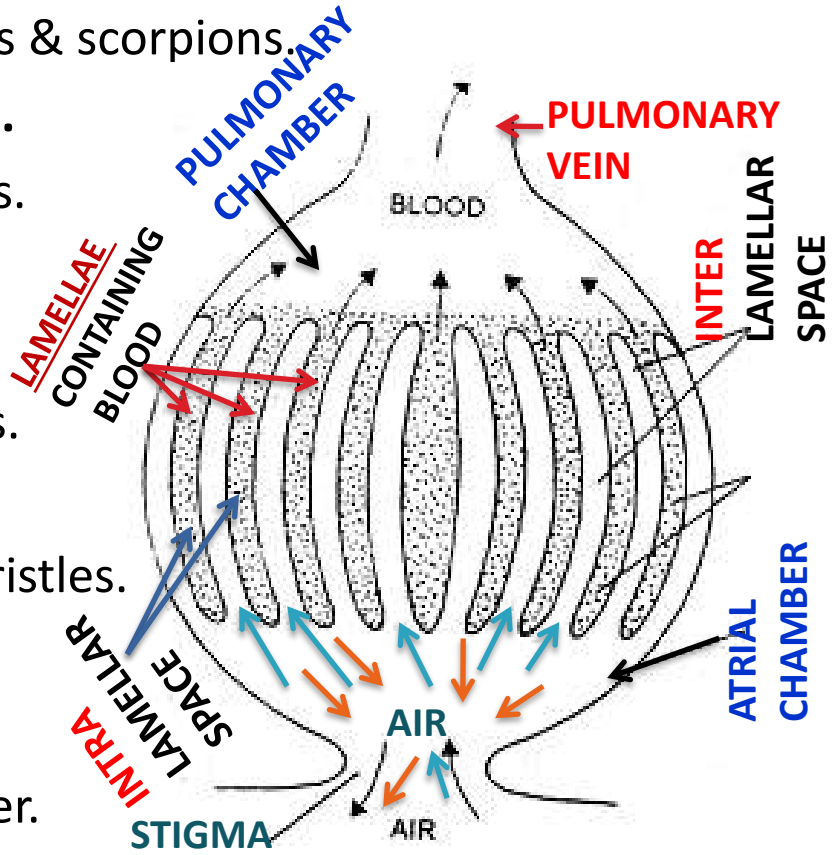
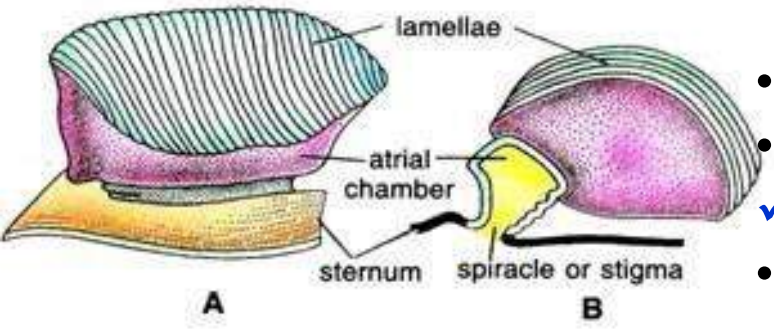


FIG.- SCORPION BOOK LUNG: VERTICAL SECTION



. Scorpion. A—book-lung in dorsal view; B—Book-lung in V.S.

- It is dorsoventrally compressed air space.
- It opens to the exterior through a stigma.

✓ **ii. Pulmonary chamber:** A distal, larger chamber.

- It holds a series of hollow parallel lamellae.
- Intra lamellar space is filled with haemolymph.
- Inter lamellar space is filled with air.

➢ Respiratory Mechanism of the Book-lungs:

✓ Ventilation:

- Alternate **muscle-contraction** and **outward air flow**

PULMONARY CHAMBER —(DORSOVENTRAL MUSCLE, Air flow)→ ARTERIAL CHAMBER —(ATRIAL MUSCLE, Air flow)→ EXTERIOR

- Alternate **muscle-relaxation** and **inward air flow**

PULMONARY CHAMBER ←(DORSOVENTRAL MUSCLE, Air flow)— ARTERIAL CHAMBER ←(ATRIAL MUSCLE, Air flow)— EXTERIOR

✓ Diffusion:

- Counter flow of air and blood in the inter lamellar and intra lamellar spaces enhance the diffusion of respiratory gases.
- Through the thin lamellar surface diffusion of gases occurs.
- The O_2 is absorbed into the haemolymph from the inter lamellar air space.
- The CO_2 is expelled out to the inter lamellar space.

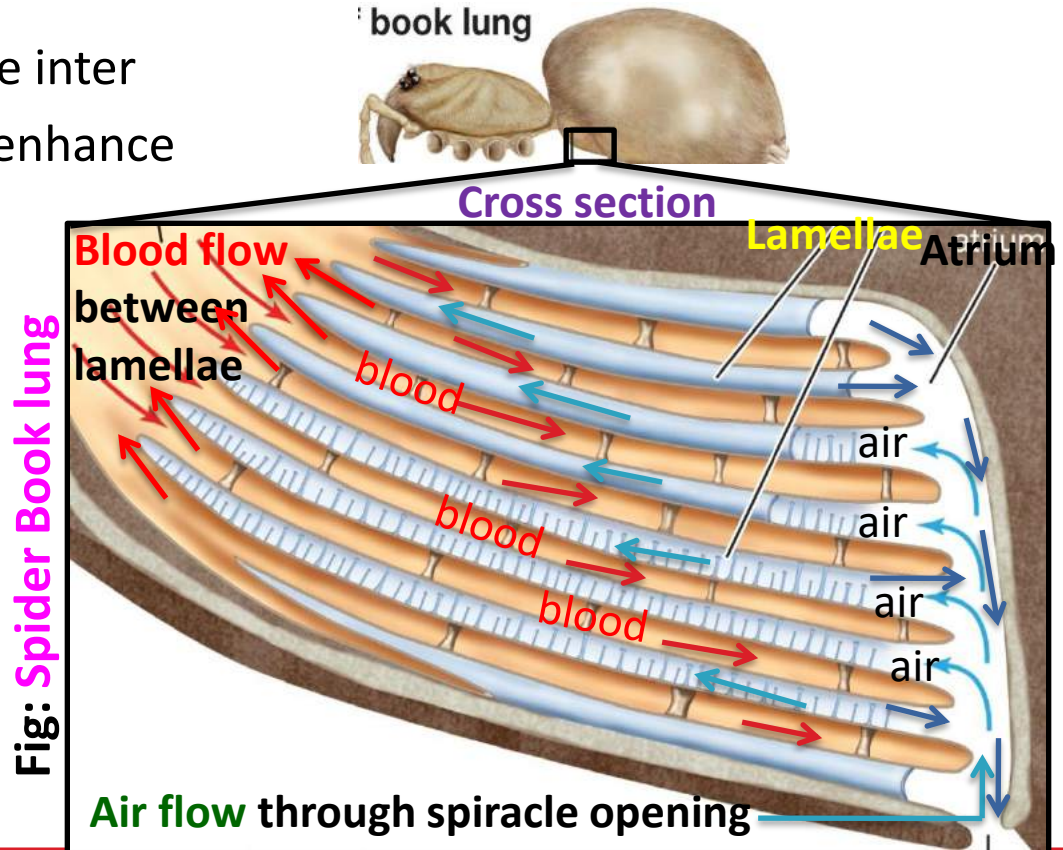


Fig: Spider Book lung

❑ 4. PSEUDOTRACHEAE OR LUNGS:

➢ **Occurrence:**

- In *Oniscus* sp. (wood lice), the only land living Crustacea.

➢ **Structure:**

- Pseudotracheae possess numerous minute tube-like structures.
- Associated with the abdominal appendages.
- lungs and tracheae develop in the external branches (exopodites).
- The respiratory structures develop more invaginations and tubules.

○ **Lungs of the Isopods: (In *Oniscus* sp.)**

- From dry to humid environments the size of the lungs and the type of embedding into the body is reduced.

➢ **Function:**

- Help in aerial respiration.

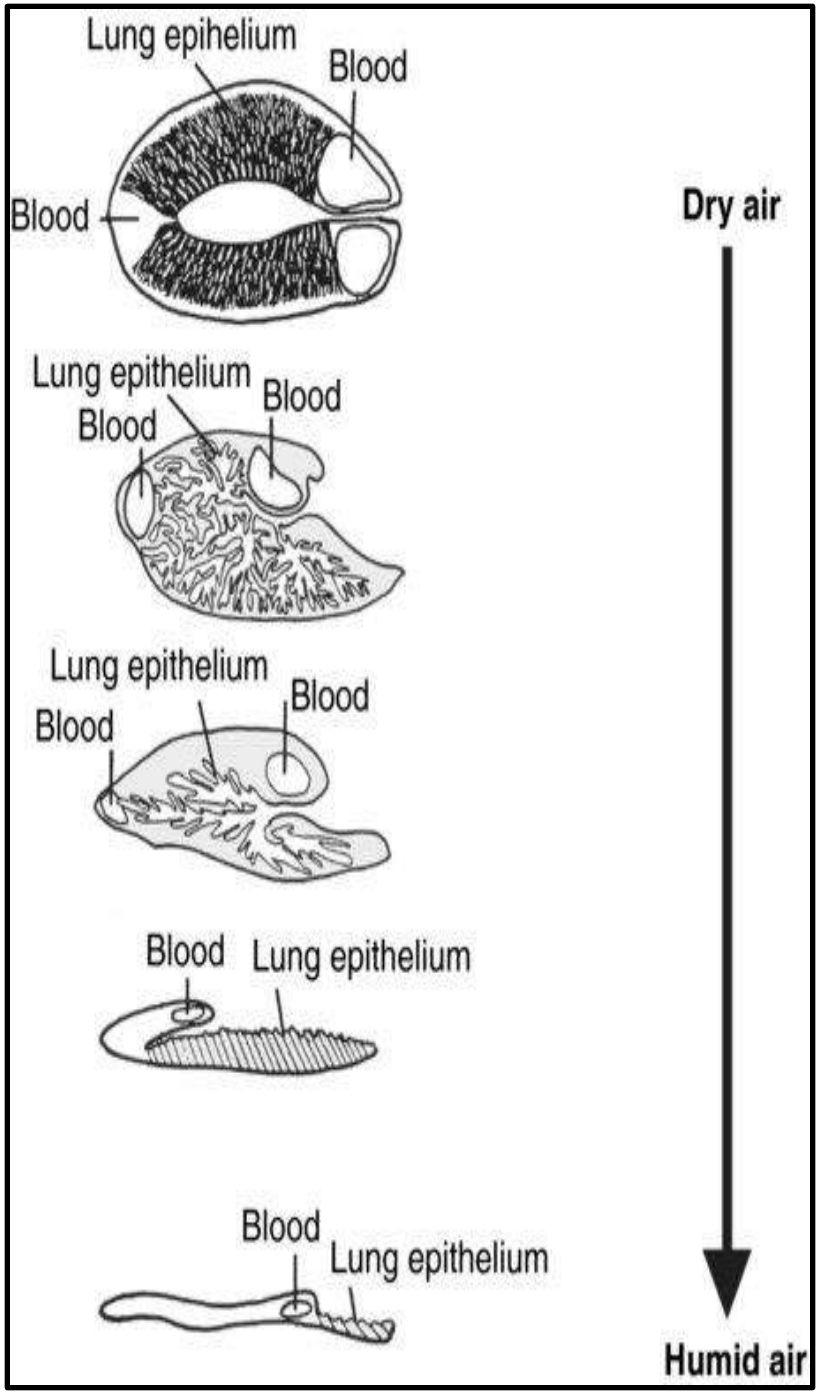


Fig-Lungs of isopods, a taxon of crustaceans.

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“Stay home Stay safe”

Thank You