## ZOOACOR03T- NON CHORDATES II

## UNIT 3 ARTHROPODA

### RESPIRATION IN ARTHROPODA

Arthropods occupy varied habitats both terrestrial and aquatic. Depending on their habitat or way of living, arthropods have any one or more of the respiratory organs given below-

**A. Body Surface**

Respiration through the body surface is generally found in small arthropods which are aquatic. Crustaceans which are smaller in size such as Copepods and Ostracods (subclasses of Class Crustacea) allow gas exchange, particularly the intake of Oxygen through their body surface since these animals have a larger surface area to body mass ratio.

**B. Gills**

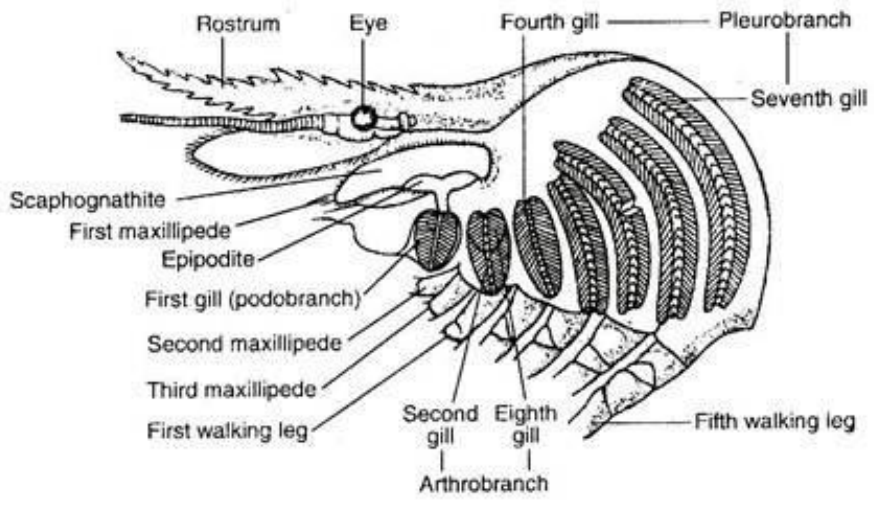
They are the principal organs of respiration in aquatic arthropods. They are best developed in class Crustacea while some other arthropods may have modified or special types of gills.

Gills are present enclosed in a gill chamber which is situated on each lateral side of the cephalothorax and covered by the gill cover (Also known as the Branchiostegite) or the carapace. The Branchiostegite is actually the inner side of the carapace which covers the cephalothorax and it has a vascularised respiratory epithelium.

The gills most commonly originate as out-pushings or evaginations of the body wall.

Structure of gill

A typical gill is crescent shaped or half-moon shaped. It consists of a central axis on each side of which are arranged blade-like gill filaments or gill lamellae, One end of each gill filament is connected to the axis while the other end is blind or free. Each gill filament is supplied by the branches of an afferent and efferent branchial channel which runs through the axis.




Gills of *Palaemon* with exposed gill chamber

Types of gills

a. Based on the shape of gill filament

i) *Phyllobranchiate gill*

In this type, the filaments are flat, broad, leaf-like and rranged in two rows.

Eg. Crabs and Prawn (*Penaeus* sp.)

ii) *Trichobranchiate gill*

In this type, the filaments are tubular or tube shaped. There is a central axis and numerous lateral filaments which are formed from the sides of the body or form an outgrowth of the skin of the legs.

Eg. Crayfish and Rock Lobster

iii) *Dendrobranchiate gill*

In this type, the leaf-like lamellae are divided into fine branched filaments.

Eg. Prawn (*Penaeus* sp.)

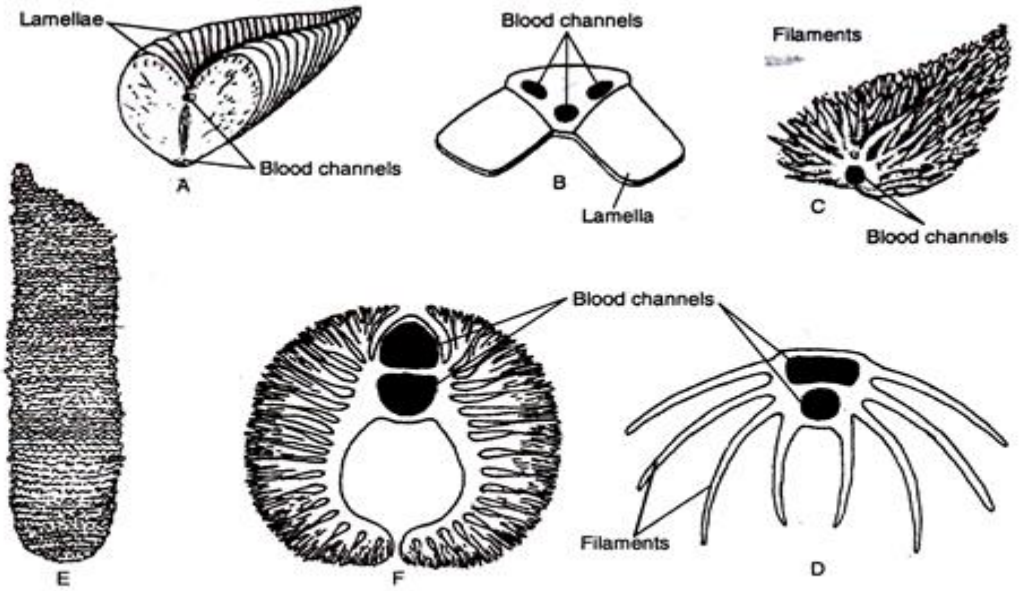



**Fig. 18.127:** Types of gills in decapod Crustacea. A. Lateral view of a phyllobranchiate gill with flat lamella, B. Transverse section of a phyllobranchiate gill. C. An entire view of a trichobranchiate gill. D. Transverse section of a trichobranchiate gill. E. An entire view of a dendrobranchiate gill. F. Transverse section of dendrobranchiate gill (from various sources).

b. Based on mode of attachment

i) *Podobranch*

Generally one pair of small gills that are attached to the coxa of cephalothoracic appendages, namely coxa of maxillipedes.

Eg. *Macrobrachium* sp., *Penaeus* sp.

ii) *Arthrobranch*

Gills are attached to the arthroidal membrane which connects the appendages of the cephalothorax.

Eg. *Penaeus* sp (11 pairs), *Palaemon* sp. (2)

iii) *Pleurobranch*

Gills are attached with the lateral wall of the thorax.

Eg. *Palaemon* sp. (5, attached to the lateral side of the thorax)

**Modification of Gills**

In Phyllocarida- Broad epipodites (the outer branch of the legs in certain crustaceans) of the thoracic appendags work as gills. Also seen in Cumea.

In Amphipoda- Gills are plate-like

In Decapoda- *Palinurus* sp.- Gills are flattened

In Phyllopoda- Laef-like pleopods (a forked swimming limb of a crustacean, five pairs of which are typically attached to the abdomen) work as gills

In Isopoda- Gills are abdominal

**Other organs of aquatic respiration**

**a. Tracheal Gills**

In the aquatic larvae of many insects a series of simple and divided external pro-cesses are attached to the abdominal seg-ments. These are richly supplied with tracheae and are called the tracheal gills.

**b. Rectal Gills**

In the nymphs of several insects the inner surface of the rectum bears gills. These gills are called the rectal gills.

**c. Book Gills**

These gills are seen in Xiphosurids like *Limulus* sp., where the abdominal appendages bear plate-like book gills covered by a gill cover. These gills are formed by the evagination of the posterior borders of opisthosoma in segments from $9^{th}$ to $13^{th}$. Each gill contains nearly 150 lamellae, which look like the delicate leaves of a book.

**d. Epipodites**

These are small highly vascularised leaf-like membranous outgrowths of integument on the outer side of coxa of the maxillipedes in first three thoracic segments. Present in Crustaceans in the anterior part of the gill chamber.

## Aerial Respiration

### C. Book Lungs

They are best seen respiratory organs of Arachnids, namely scorpions and spiders. Book lungs are blind sac-like structures originating from the evaginations of opisthosoma within which there are delicate folds of the inner lining arranged like the leaves of a book. These folds are richly vascularised and thus respiration is circulation dependent. Each book lung communicates to the exterior by a stigma. They are regarded as modified abdominal appendages.

Each book lung consists of an air cavity or atrial chamber on the ventral side which opens to the outer side by a slit-like spiracle or stigmata that opens on the ventro-lateral side of the sternum. Dorsal part of book lung consists of nearly 150 vertical folds or lamellae arranged like leaves of a book. Each lamella is a hollow structure, made of two thin layers of respiratory epithelium.

The air breathing in the book-lungs is effected by the action of the dorso-ventral and atrial muscles. Contraction of the dorso-ventral muscles compresses the pulmonary chamber so that the air from the chamber is forced out through the stigmata. When the atrial muscles contract the book-lungs expand creating vacuum and sucking fresh air in through the stigmata.

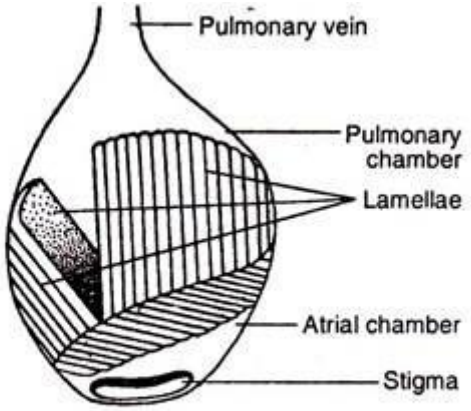



**Fig. 18.110:** Showing the structural organisation of a book-lung of scorpion.

### D. Tracheal System

This is the most important organ for aerial respiration. This chitin-lined tube is seen in almost all land arthropods, such as insects, centipedes, millipedes and also in many arachnids. The tracheae originate as invagination of the body wall as opposed to gills which are evaginations.

Two types of tracheae are seen:

**Ventilation trachea**—oval in section and collapses after the exhalation of air and **Diffused trachea**—rigid and does not collapse after the exhalation.

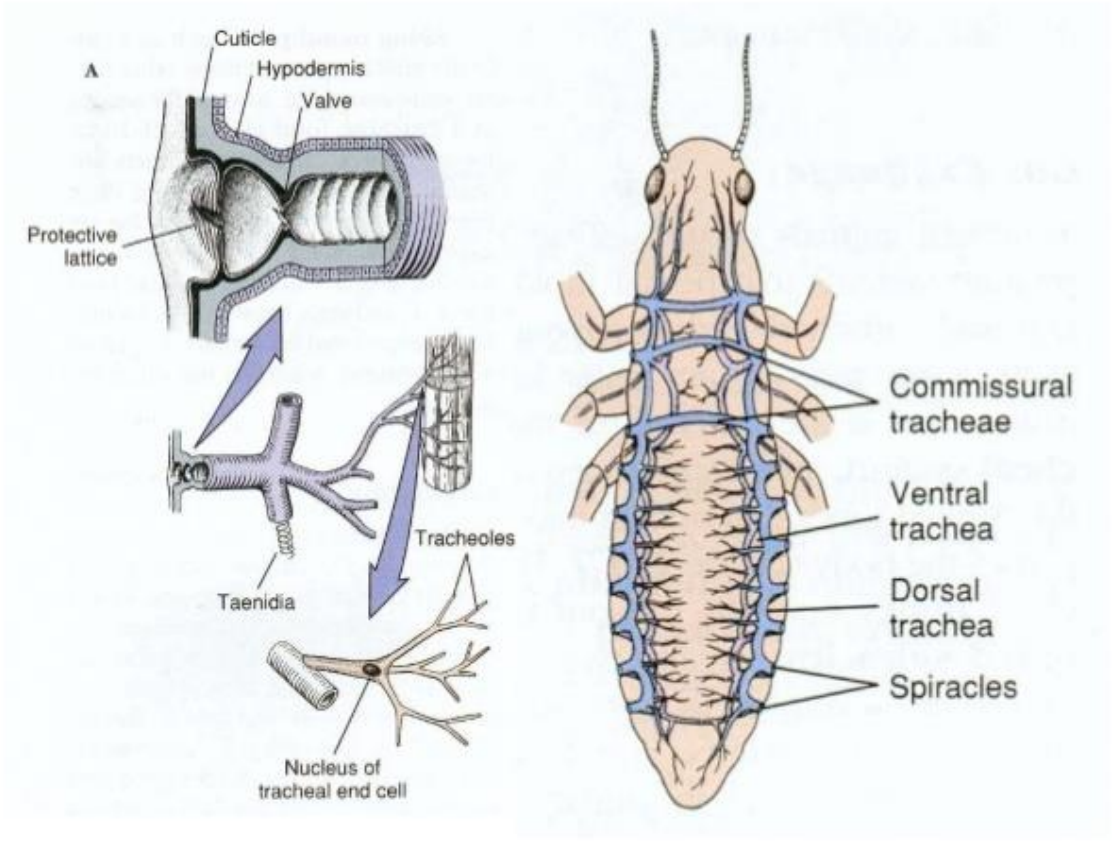
Structures of trachea

Each trachea is a tube with walls made up of polygonal cells. The wall of trachea is composed of three layers—these are the internal layer, called intima, a middle layer of epithelium and an outer layer of basement membrane. The intima is lined by spiral cuticular ridges, called taenidea, that prevent collapse.

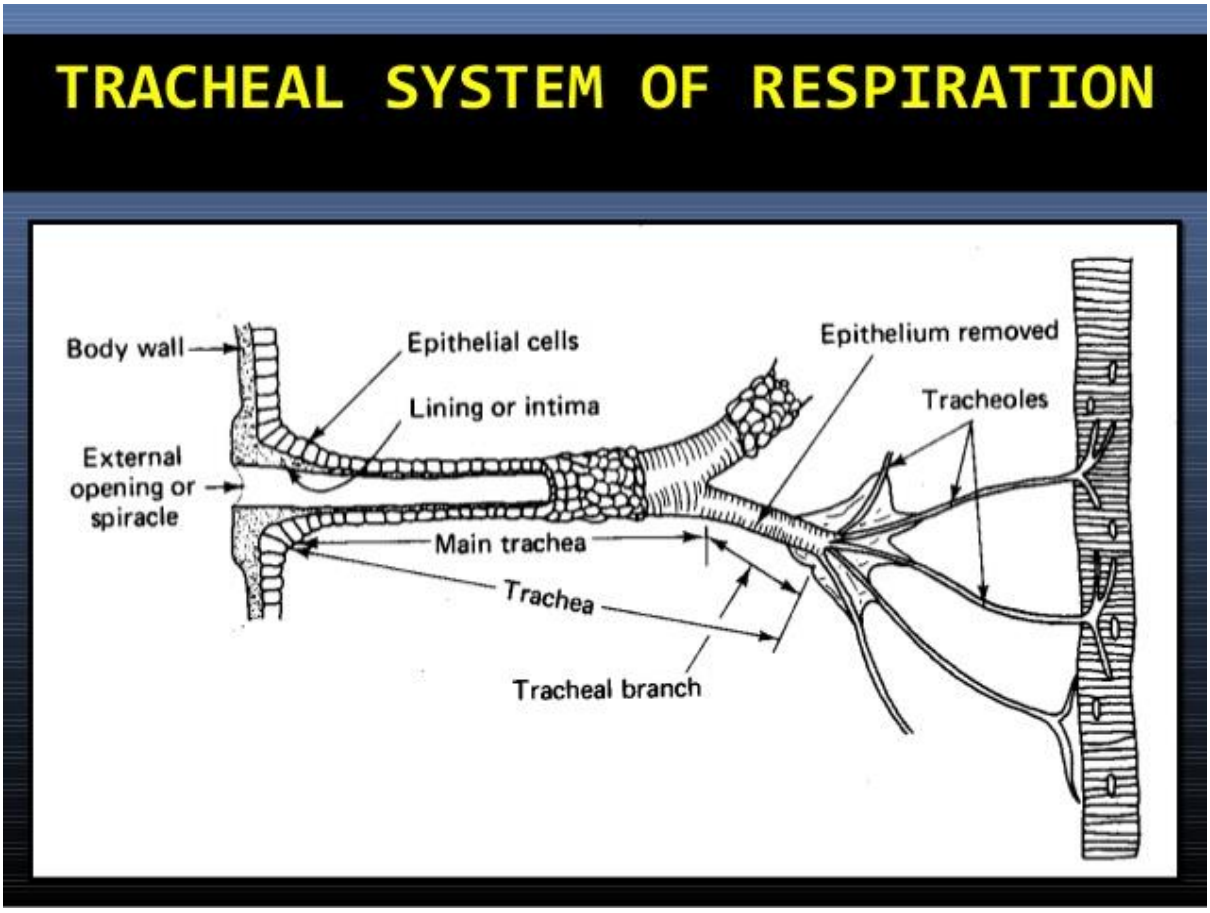
The tracheae open externally by small openings, called spiracles or stigmata. These spiracles are located along the sides of the body. Each spiracle opens into a chamber, called atrium and the spiracle is placed on a plate, called penetrene. Each spiracle has two lids for opening and closing. Within the chamber foreign particles are eliminated by a filtering apparatus, containing either special bundles of setae or a kind of sieve-like membrane. Some parts of tracheae are dilated to form air-sacs. They help as reservoirs of air.

The finer branches of tracheae are called tracheoles which are without inner taenidial ridges. A tracheole may be 1µ in diameter and reaches every cell of the body. Instead they are lined by a protein called trachein and are usually filled with a fluid in which oxygen dissolves and diffuses to the tissues. The tracheal system carries oxygen directly to the body cells and does not require blood to transport it. Generally there are 10 pairs of spiracles in insects, two pairs are thoracic and eight pairs are abdominal.

Breathing is affected by the paired tergo-sternal muscles which connect dorsal side of body with the ventral side and hence their contraction compresses the abdominal cavity forcing air to move out. Relaxation of these muscles brings the abdominal cavity into its original shape, sucking the air into the tracheal tubes.




A typical tracheal system in an insect




Modification of tracheal system in adult arthropods

Two pairs thoracic and eight pairs abdominal spiracles are usually present in all adult insects. There are 12 pairs in primitive condition.

In certain forms some spiracles may be secondarily absent but they appear at least in some stages of development. For example, the queen termite has only six pairs of abdominal spiracles instead of eight pairs. The metathoracic pair of spiracles is absent in Orders Lepidoptera, Hymenoptera, Coleoptera and a few others.

In millipedes, a pair of spiracles is present in each thoracic segment and two pairs of spiracles in each abdominal segment.

Types of Tracheal System in Insect Larvae

Based on functional spiracles

i) *Polypneustic*

Tracheal system open-ings to the exterior by 8 or more pairs of functional spiracles. It may again be subdivided into:

*Holopneustic*- When 2 pairs of tho-racic and 8 pairs of abdominal spiracles are functional. The term is used when 10 pairs of functional spiracles are present.

*Peripneustic*- A respiratory system with 1 thoracic and 8 abdominal spiracles are present on each side of the body. The term is denoted when the abdominal spiracles occur on all the segments of the abdomen.

*Hemipneustic*- A respiratory system with 1 thoracic and 7 abdominal spiracles are present on each side of the body. The term is used when one or more pairs of spiracles are non-functional.

ii*) Oligoneustic*

In this type, either one or two pairs of spiracles are functional.

It can be divided into the following three types-

*Amphipneustic*- When one pair of thoracic and one pair of post-abdominal spiracles are present.

Eg.- Larva of the common house fly.

*Metapneustic*- Only one pair of post abdominal spiracles is functional.

Eg.- Larva of mosquito.

*Propneustic*-Only one pair of tho-racic spiracles is functional.

Eg,- The pupae of certain Diptera.

iii) *Apneustic*- No spiracle is present in functional state. Gaseous exchange takes place through the integument, seen among aquatic insect larvae.