

## STRUCTURE AND FUNCTIONS OF RESPIRATORY SYSTEM

Similar to aerobic animals, insects must obtain oxygen from their environment and eliminate carbon dioxide respired by their cells. This is **gas exchange** through series of gas filled tubes providing surface area for gaseous exchange (Respiration strictly refers to oxygen-consuming, cellular metabolic processes). Air is supplied directly to the tissue and no haemolymph (blood) is involved in the respiratory role. Gas exchange occurs by means of internal air-filled **tracheae**. These tubes branch and ramify through the body. The finest branches called **tracheloe** contact all internal organs and tissues and are numerous in tissues with high oxygen requirements. Air usually enters the tracheae via **spiracular openings** positioned laterally on the body. No insect has more than ten pairs (two thoracic and eight abdominal).

Based on the **number and location** of functional spiracles respiratory system is **classified** as follows

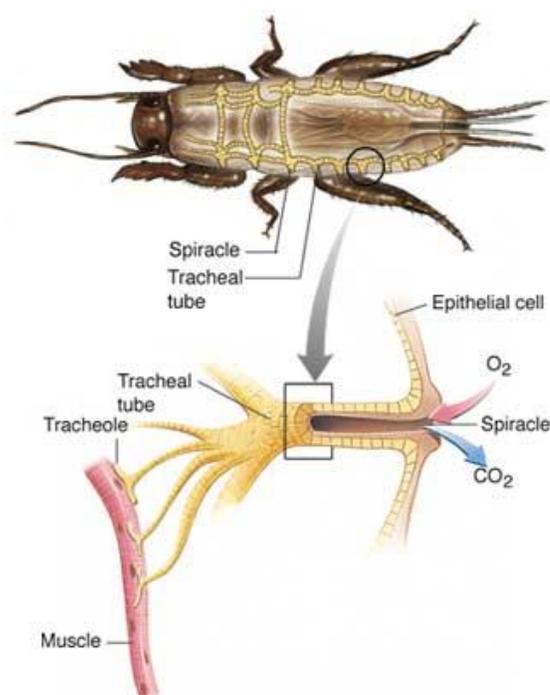
1.	Holopneustic	10 pairs, 2 in thorax and 8 in abdomen. e.g. grasshopper
2.	Hemipneustic	Out of 10 pairs, one or two non functional
3.	Peripneustic	9 pairs - 1 in thorax 8 in abdomen. e.g. Caterpillar
4.	Amphipneustic	2 pairs - One anterior, one posterior, e.g. maggot
5.	Propneustic	1 pair -anterior pair e.g. Puparium
6.	Metapneustic	1 pair - posterior pair e.g. Wiggler
7.	Hypopneustic	10 pairs - 7 functional (1 thorax + 6 abdominal), 3 non functional. e.g. head louse
8.	Apneustic	All spiracles closed, closed tracheal system e.g. naiad of may fly.

## ORGANS OF RESPIRATION

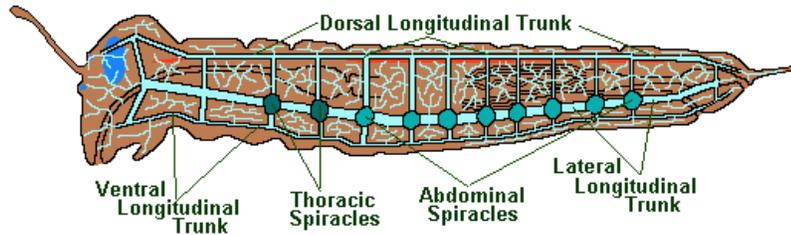
### SPIRACLES

Spiracles have a chamber or **atrium** with a opening and closing mechanism called **valve**. This regulates air passage and minimise water loss. Each spiracle is set in a sclerotized cuticular plate called a **peritreme**. Tracheae are invaginations of the epidermis and thus their lining is continuous with the body cuticle. The ringed appearance of the tracheae is due to the spiral ridges called **taenidia**. This allows the tracheae to be flexible but resist compression. The cuticular linings of the tracheae are shed when the insect moults, but not the linings of tracheoles.

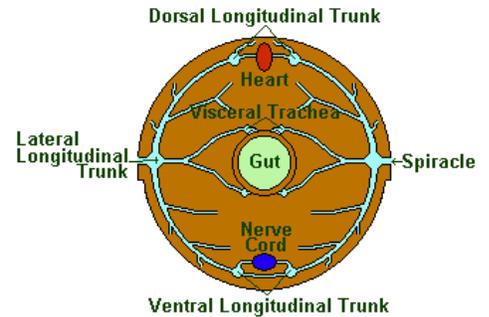
**Tracheoles** are less than 1  $\mu\text{m}$  in diameter; they end blindly and closely contact the respiring tissues. Taenidia and waxlayer is absent. Cuticulin layer is permeable to gases. It is intracellular in nature, but enclosed only in the cytoplasm of tracheal and cell called **tracheoblast**. Gaseous exchange occurs across tracheoles. There are four tracheal trunks viz., lateral, dorsal, ventral and visceral, helping in the passage of air. In the trachea, thin walled-collapsible sac like dilations are present, called as **airsacs** where taenidia is absent. Airsacs acts as oxygen reservoir. Provide buoyancy to flying and aquatic insects. Provide space for growing organs. Acts as sound resonator and heat insulators.



## Diagrammatic Representation of the Insect Tracheal System



## Diagrammatic Representation in TS of the Insect Tracheal System



### Mechanism of respiration

Oxygen enters the spiracle and passes through the length of the tracheae to the tracheoles and into the target cells by a combination of **ventilation and diffusion** along a concentration gradient, from high in the external air to low in the tissue. Where as the net movement of oxygen molecules in the tracheal system is inwards (**Inspiration**), the net movement of CO<sub>2</sub> and water vapour molecules is outwards, (**Expiration**).

### Respiration in aquatic insects

#### 1. Closed tracheal system

In some aquatic and many endoparasitic larvae spiracles are absent and the tracheae divide peripherally to form a network. This covers the body surface, allowing cutaneous gas exchange. e.g. Gills : Tracheated thin outgrowth of body wall.

Lamellate gills - mayfly naiad

Filamentous gills - damselfly naiad

Rectal gills - dragonfly naiad

2. **Open tracheal system**

- i. Air store: Air bubble stored beneath wings acts as physical gill, e.g. water bug.
- ii. Respiratory siphon - e.g. Wiggler
- iii. Caudal breathing tube -e.g. Water scorpion
- iv. Plastron: Closely set hydrofuge hairs of epicuticle hold a thin film of air indefinitely.