

RESPIRATORY ORGANS IN INVERTEBRATES

Dr. Sunita Kumari Sharma
Associate Professor and Head
P.G. Department of Zoology
Maharaja College, Ara

INTRODUCTION

The respiration involves the exchange of gases between the body and environment. The animals take oxygen from the surroundings and give off carbon dioxide to the environment. The oxygen is chemically utilized to oxidize food stuffs to produce energy. The energy is utilized by the living organisms. Animals may have skin, lungs, gills, etc. as the devices of respiration. Physiologically animals get oxygen from water, from air or living in water but breathe air. All these devices and categories are met in aquatic arthropods as described below:

In aquatic arthropods, gills, book gills, epipodites, tracheal gills, blood gills, rectal gills, etc. are found as respiratory organs.

GILLS

The gills (originated as out pushing of body wall) are well developed in crustaceans and typically associated with appendages. The organization of gills includes the following:

a. Origin of gills

These are outgrowths of thoracic limbs in arthropods and in isopods, 2nd and 5th pleopods are modified as gills.

b. Shape of gills

It is typically crescent-shaped containing a rod and blade like gill filaments. One end of filament connected with rod and blood vessel enters into it through this region. The other end of filament is free. The decapods contain all the types of gill with great variation.

c. Number of gills

Gills are absent in *Lucifer* (Shrimps) but Penacid, *Homarus*, Peacarb has 24, 20 and 6 gills respectively.

d. Size of gills

The anterior gills are small and the size increases towards the posterior end.

e. Types of gills

A. On the basis of position

I. Dendrobranchiate gills: It contains a central axis and two series of main branches with a number of sub-branches or dendrites. e.g., *Penaeus*.

II. Phyllobranchiate (=lamellar) gills: It have a central axis and two series of leaf like flattened gill plates arranged in the form of leaves of a book. e.g., *Palaemon* (Prawn).

III. Trichobranchiate (=filamentous) gills: It contains a central axis and several series of filamentous branches. e.g., Cray fish (*Astacus*).

B. On the basis of origin of attachment

I. Pleurobranch or aide gills: It is attached to lateral wall of segment above the origin of thoracic appendages.

II. Podobranch or foot gills: It is attached to coxa of the appendages and represents a modification of a part of an epipodite.

III. Arthrobranch or joint gill: It is attached to arthrochial membrane.

f. Modifications of gills:

I. Broad epipodites of thoracic appendages work as gills in phyllocardia and cumacea.

II. In *Palaemon* (Decapoda), gills are flattened.

III. Gills are plate like in amphipoda. Leaf like pleopods work as gills in Phyllopora.

IV. In Euphausiacea, tufted podobranchs are not covered by carapace.

V. The gills are a row of small branchial lamellae on each side of cyprididae.

VI. Abdominal gills are present in stomatopoda and isopoda.

VII. Tracheal gills

A series of simple and divided external process attached to abdominal segments. These are richly supplied with trachea and tracheoles. e.g., Aquatic larvae of many insects. In *Culex*, four leaves like tracheal gills are present surrounding the anus. It probably takes oxygen dissolve in water. Naiad of mayfly and damselfly bears 7 pairs and 3 pairs of tracheal gills.

VIII. Blood gills

The tracheas are replaced by branching of blood vessels. e.g., Trichopterous and tripulid larvae.

IX. Rectal gills

The inner surface of rectum bears gills. e.g., Nymphs of several insects.

X. Book gills

These are formed by evagination of posterior border of opisthosoma from 9th to 13th segments. Each gill contains nearly 100-200 lamellae as delicate leaves of a book. The lamellae are actual surface for gaseous exchange. The movement of gill lamellae maintains the circulation of water around the gills where gaseous exchange takes place.

AERIAL RESPIRATORY ORGANS (TRACHEA AND LUNGS) IN ARTHROPODS

The respiration involves the exchange of gases between the body and environment. The animals take oxygen from the surroundings and give off carbon dioxide to the environment. The oxygen is chemically utilized to oxidize food stuffs to produce energy. The energy is utilized by the living organisms. Animals may have skin, lungs, gills, etc. as the devices of respiration. Physiologically animals get oxygen from water, from air or living in water but breathe air. All these devices and categories are met in aerial arthropods as described below:

AERIAL RESPIRATION

In arthropods, aerial respiration occurs through trachea, lungs, book lungs, spiracular gills, tracheal gills and modification of trachea.

A. trachea

It is present in almost all aerial arthropods but is well developed in insects. In insects, respiration has no relation with circulation. The trachea (circulatory system of vertebrates) is an invagination of cuticle. Each trachea opens to the exterior through a small circular opening or spiracles. Generally thorax and abdomen bears two and eight pairs of spiracles respectively.

The spiracle is supported by peritreme (annular sclerite) and capable of closed by sphincter or spiracular muscle. In some insects, spiracles are present in a cavity or atrium. In some terrestrial insects, atrium is provided with filtering apparatus.

The wall of tracheal tube is made up of polygonal cells having spiral ridges of cuticle or taenidia. The smallest subdivision of trachea is known as trachiole. The trachioles are present in cluster. The cuticle of trachioles is not shed during moulting. The trachioles are lined by trachicin.

The spiracles are present on a plate like structure called peritreme. Each spiracle has two lids for opening and closing.

Some parts of trachea are dilated to form air-sacs which work as reservoir. The air-sac lacks taenidia. Air-sacs are present in grass hopper, butter fly, cicadas, scarab and beetles.

Types of trachea

(a) On the basis of appearance:

1. Ventilation trachea: This is oval in section, collapses after exhaustion of air and
2. Diffused trachea: They are rigid and do not collapse after exhaustion.

(b) In larval stages:

1. Polypneustic: It has eight or more functional spiracles. It is subdivided into:

I. Holopneustic: Two thoracic and eight abdominal open spiracles present. E.g., Cockroach, most adults.

II. Peripneustic: One thoracic and eight abdominal open spiracles present.

III. Hemipneustic: One thoracic and seven abdominal open spiracles present. E.g., beetles and butterfly.

2. Oligopneustic: It one or two functional spiracles. It is subdivided into:

I. Amphipneustic: One pair of thoracic and one pair of posterior abdominal spiracles.

II. Metapneustic: One pair of posterior abdominal spiracles.

III. Propneustic: One pair of thoracic spiracles.

3. Apeustic: Functional spiracles absent. e.g., Collmebole. Parasitic larvae, Hymenoptera, endoparasite insects.

Number of spiracles

1. In certain insects, spiracles are absent but they are present during larval stages.

2. Queen of termite has only six abdominal spiracles.

3. Metathoracic spiracles are absent in Lepidoptera, Hymenoptera and Colleoptera.

Modifications of spiracles

1. Irregular tracheal pits open to unbranched tracheal systems in Onychophora.

2. Tracheas are absent in Collembola.

3. In *Machiles*, segmental tracheae originate from spiracles but do not have trunks.

4. In the larvae of housefly, dorsal longitudinal trunk is provided with one pair of anterior and posterior apertures.

5. Single spiracle is connected to dorsal trunk in mosquito larvae.

6. In Myriapoda, stigmata open within air chamber from where large number of tracheae is given off.

7. Tracheae are branched in Diplopoda.

8. Symphyla has only two tracheae on heart.

9. Pseudotracheae are present in crustacea, wood lice. These are formed by numerous minute tube like structures which traverse the pleopods.

B. Lungs

The upper part of gill chamber is separated from the rest and forms a closed chamber within which vascular tuft project is known as lung. E.g., *Birgus*.

C. Book lungs

These are modified abdominal appendages and originate from evaginations of episthosoma as blind sacs. It is dividing into ventral (=atrial) chamber and dorsal or posterior (=pulmonary) chamber. The atrial chamber opens to the exterior through stigmata and pulmonary chamber receives the

pulmonary vein. The pulmonary chamber contains 150 lamellae in vertical folds. The lamellae are highly vascular, parallel arranged as leaves of a book and bear air spaces filled with air. The respiratory movement is regulated by atrial muscles. It is best seen in scorpionids.

D. Plastron respiration

In aquatic insects, the angle of contact between water surface and particular body region is known as hydrofuge. The air film is held so firmly by a region of hydrofuge hair which cannot be replaced by water. This very thin, firmly held layer of air is known as plastron. Functionally, it resembles a tracheal gill more than an air store. It is seen in riffle, beetle, *Coxelmis*, *Eimis*.

E. Spiracular gills

These are filamentous outgrowth of ectoderm, covered with a thin cuticle. It can resist high pressure. E.g., larvae of *Teicheomyza*, pupa of *Simuliura* and psephenoids etc.

F. Anal respiration

Rhythmic contraction of intestine takes in and expels out water. It is common in Cyclops.
