

VISION AND RESPIRATION IN ARTHROPODA

Arthropoda, the largest phylum of the animal kingdom, shows extraordinary diversity not only in body structure but also in sensory and respiratory adaptations. Two of their most remarkable systems are **vision** and **respiration**, which illustrate evolutionary changes from simple to complex forms as arthropods conquered both aquatic and terrestrial habitats.

VISION IN ARTHROPODA

Vision in arthropods ranges from simple light perception to complex image formation and color detection. Their eyes are highly specialized for detecting motion, light intensity, color, and polarization .

1. Types of Eyes in Arthropods

Arthropods possess two principal kinds of eyes:

(a) Simple Eyes or Ocelli

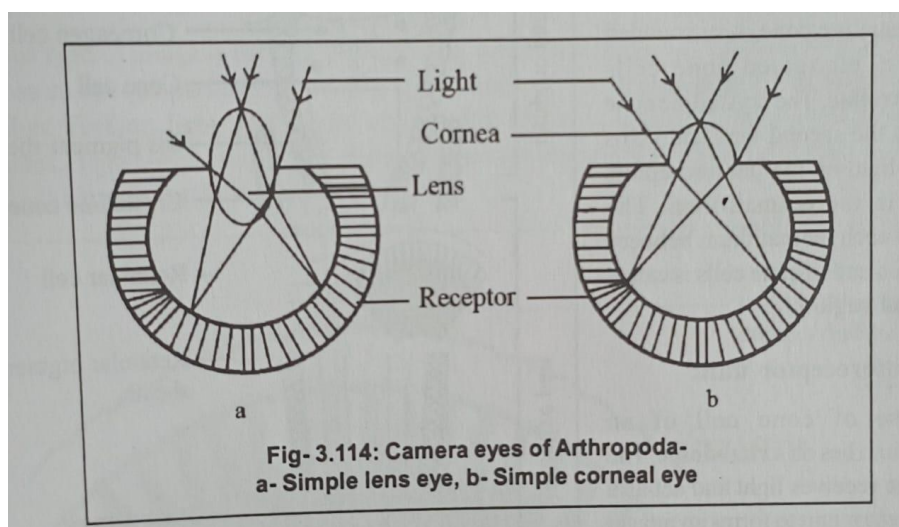
Simple eyes consist of a **single lens** and a few photoreceptor cells. They are Found in **larval insects, adult spiders, myriapods, and some crustaceans**. They **do not form images** but are sensitive to changes in light intensity. They Function mainly to regulate **circadian rhythms**, orientation, and flight stability. For example, honeybees use ocelli to maintain orientation relative to sunlight.

Structure of an Ocellus:

Transparent **cuticular lens**.

Underlying **retina** with photoreceptor (retinula) cells containing visual pigment (rhodopsin).

Pigment layer isolates it from neighboring cells to prevent light scattering.



(b) Compound Eyes

Compound eyes are the hallmark of arthropod vision, especially in **insects and crustaceans**. They consist of numerous visual units called **ommatidia**, ranging from a few to over 25,000 in dragonflies. Each ommatidium captures light from a small portion of the visual field collectively producing a **mosaic image**.

2. Structure of an Ommatidium

Each ommatidium is a tiny, functional unit with the following parts:

1. **Corneal Lens** – It is Transparent and outer cuticular covering that collects light.
2. **Crystalline Cone** – A transparent cone-shaped structure beneath the lens that focuses light onto photoreceptor cells.
3. **Retinula Cells (Photoreceptor Cells)** – Usually eight in number, each containing light-sensitive pigment rhodopsin.
4. **Rhabdom** – A central light-sensitive rod formed by microvilli of retinula cells where light is converted into nerve impulses.
5. **Pigment Cells** – Surround each ommatidium to isolate it optically from others.
6. **Optic Nerve Fibres** – Carry signals from retinula cells to the optic ganglia and brain.

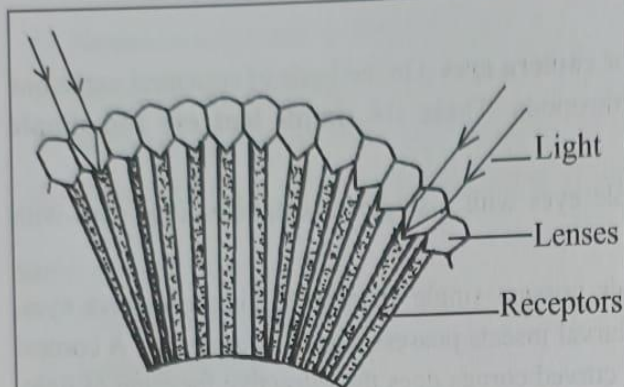


Fig- 3.114: Basic structure of a compound eye of an insect and crustacean.

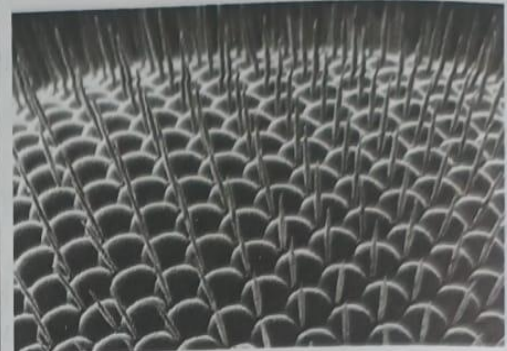
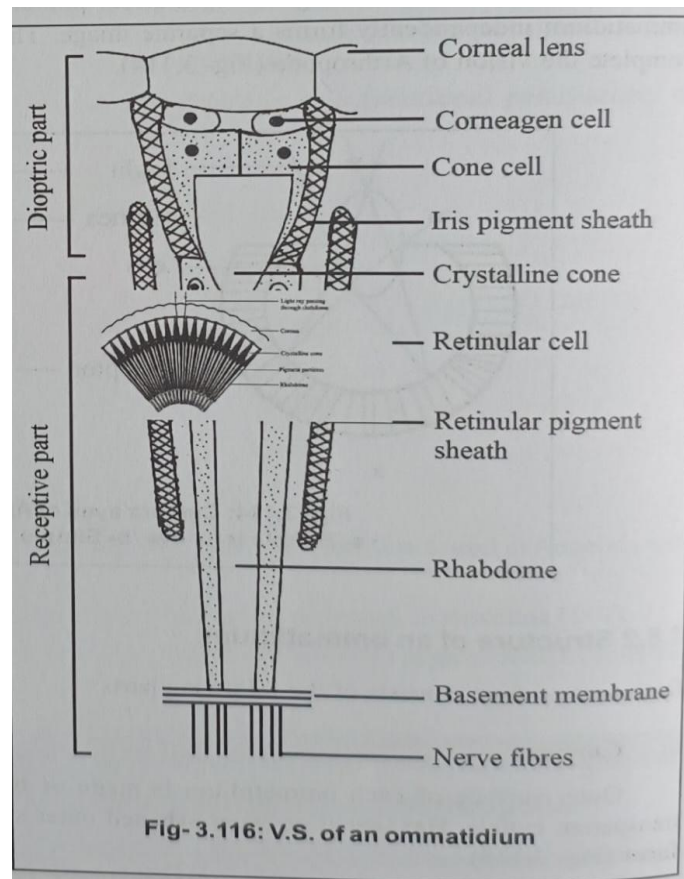


Fig- 3.115: Compound eye of *Drosophila* showing corneal facets.



3. Types of Compound Eyes

(a) Apposition Eyes

- Found in **day-active (diurnal) insects** such as bees, butterflies, and dragonflies.
- Each ommatidium is optically isolated by pigment cells.
- Each one forms a small, separate image; the brain integrates them into a **mosaic image**.
- Functions best in bright light; produces high resolution.

(b) Superposition Eyes

- Found in **nocturnal insects** (e.g., moths) and **many crustaceans**.
- Pigment cells are displaced, allowing light rays from several ommatidia to combine.
- Forms a brighter, single image; ideal for **dim-light vision** but lower in sharpness.

4. Mechanism of Vision

When light strikes rhodopsin in the rhabdom, it undergoes photochemical changes leading to depolarization of retinula cells, generating an **action potential** transmitted to the optic lobe and brain. The integration of these impulses from many ommatidia forms a **mosaic image**.

The more the number of ommatidia, the finer the resolution. Example: Dragonflies have ~28,000 ommatidia per eye, giving exceptional motion

RESPIRATION IN ARTHROPODA

Respiration in arthropods shows evolutionary adaptation to almost every habitat from deep oceans to arid deserts. The diversity of respiratory organs is striking, demonstrating a gradual transition from **gills** (aquatic) to **book lungs** and **tracheae** (terrestrial).

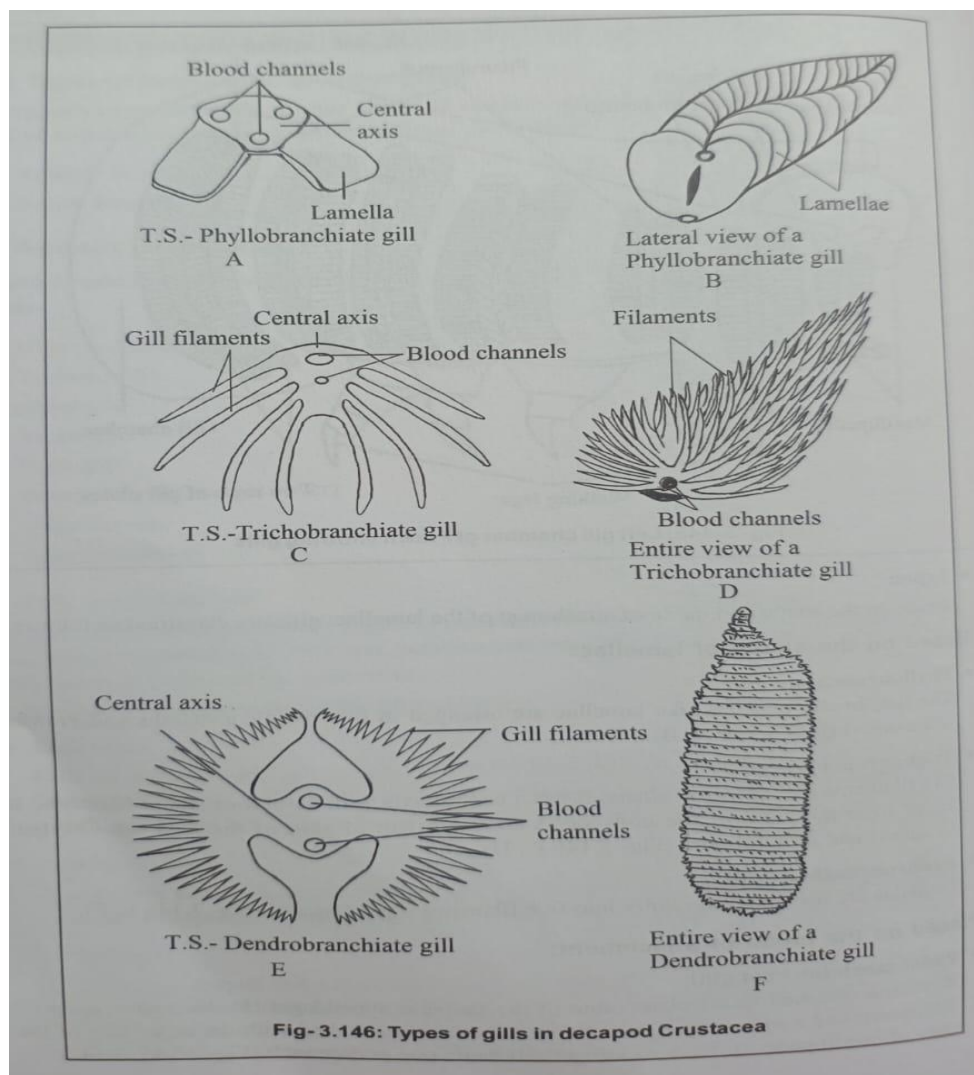
1. Aquatic Arthropods – Gills

Gills are **thin-walled, feathery outgrowths** of the body wall or appendages. They are Richly supplied with blood capillaries. **Gas exchange** occurs between blood and surrounding water by diffusion. Gills are Usually located in a **branchial chamber** beneath the carapace. Continuous water flow is maintained by movement of specialized appendages.

Example: Prawn, Crab, Lobster (Class Crustacea)

Mechanism:

Water enters through openings near the base of legs, passes over gills, and exits posteriorly. Then, Oxygen diffuses into haemolymph and CO₂ diffuses out.



2. Arachnids – Book Lungs and Book Gills

(a) Book Lungs

Consist of **leaf-like lamellae** arranged like pages in a book, enclosed in a chamber. Each lamella contains haemolymph; air circulates between them. Air enters through **spiracles** and diffuses across lamellae. Found in the **ventral abdomen**, typically four pairs in scorpions. They are commonly found **in spiders and scorpions**

(b) Book Gills

External flap-like appendages with leaf-like gill plates. Used for respiration and limited swimming. Each gill plate bears lamellae where gaseous exchange occurs between water and haemolymph. They are generally found **in horseshoe crab, *Limulus***.

3. Insects – Tracheal System

Tracheal system is the most advanced and efficient terrestrial respiratory system among arthropods.

Structure:

A network of **air-filled tubes** called **tracheae** open to the outside through **spiracles**. Tracheae branch repeatedly into finer **tracheoles** that reach individual cells. The inner lining is **chitinous**, preventing collapse. Some insects have **air sacs** that aid in ventilation.

Mechanism:

Air enters through spiracles → tracheae → tracheoles → cells.

Oxygen diffuses directly to tissues and CO₂ diffuses out through the same path.

Gaseous exchange occurs without the involvement of blood.

