

Lec. 5

The Open Circulatory System

Insects possess an "open" circulatory system in which an insect's blood (hemolymph) fills its body (hemocoel) rather than being contained within vessels (closed systems) as in most higher animals. **hemolymph** consists of **haematocytes** and **plasma**. The main driver of hemolymph circulation in the central body cavity is the dorsal vessel, which is usually divided into an **aorta** in the **thorax** and a **heart**. The **heart** is tube-like located in the **dorsal part of the abdomen** and divided into **chambers** separated by small valve-like openings called **ostia**, through which blood enters the heart. Each chamber has a **pair of alary muscles** which expand and contract to facilitate the flow of hemolymph through the heart. Peripheral circulation in the appendages, however, is driven by autonomous pumps known as accessory **pulsatile organs**, or auxiliary hearts.

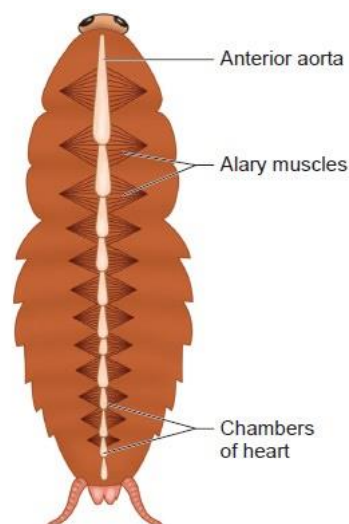


Fig. (1) Shows the parts of Circulatory system of Cockroaches

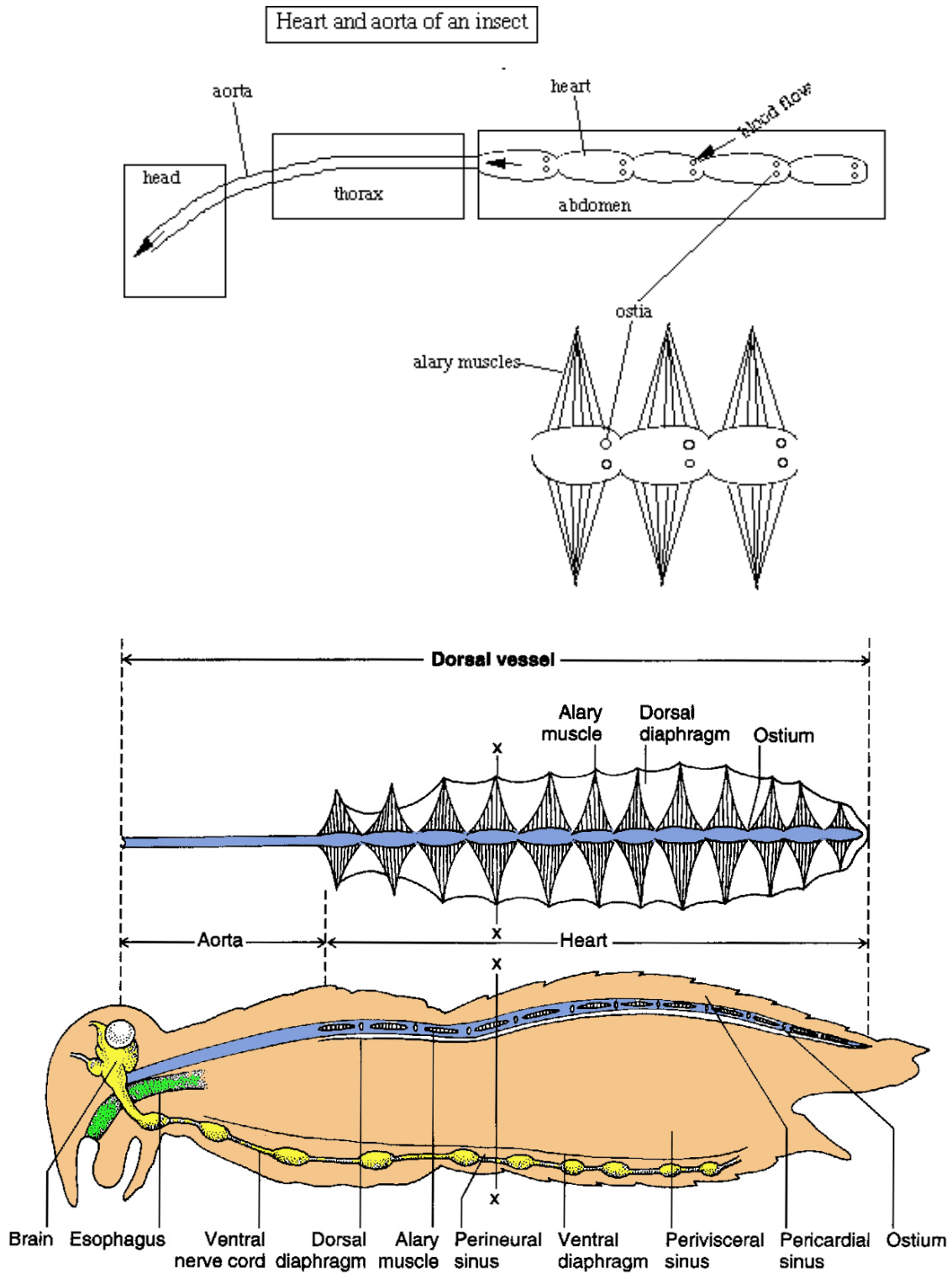


Fig. (2) Circulatory system of grasshoppers

The main characteristics of circulatory system

1. The major portion of the "blood" or hemolymph is not found within vessels.

2. The circulatory system of insects do not rely on transport of oxygen. This instead is done by the tracheal system.
3. Hemolymph enters the dorsal vessel or heart via small openings called ostia.
4. The hemolymph is then pumped towards the head where it then returns to the hemocoel.

What is hemolymph?

Is a clear fluid, colorless, or (slightly yellow and green) because of certain pigments? Is being about 5-40% of the total body weight with pH 6-7 slightly acidic.

Contents of hemolymph

1. Plasma (watery fluid) - about 90%.
2. Organic molecules - amino acids, sugars, lipids, glycerol& hormones.
3. Inorganic ions - dissolved salts of Na, K, Ca, Mg.
4. Blood cells (hemocytes).

What is hemocyte?

A hemocyte is a cell that plays a role in the immune system of invertebrates. It is found within the hemolymph. Most of the haematocytes are phagocytic leucocytes. These alter considerably in appearance at different stages of development, assuming many different forms.

Hemocytes functions

1. Phagocytosis:- Phagocytosis is characterized by the uptake of large particles, parts of cells and even whole microorganisms or other cells. Whereas in insects it is achieved by granular cells and plasmatocytes

2. Coagulation

3. Encapsulation of foreign objects including parasite

Types of Hemocyte cells

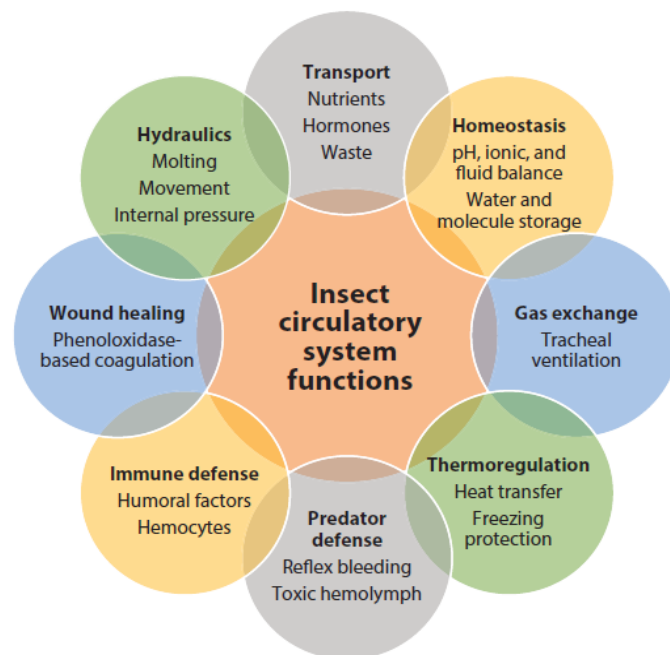
1-Phagocytes 2- Plasmacytes 3- Lamellocytes 4- Prohemocytes

5- Granulocytes 6- Spherulocytes 7- Coagulocytes 8- Fibrocytes

9- Adipocytes 10- Oenocytes 11- Crystal cells 12- Secretory cells

13- Granular leukocytes cells.

Functions of Circulatory system



Functions of the heart

- 1) Transport of nutrients around the body
- 2) Movement of limbs, mouthparts, antennae
- 3) Moulting - by increasing pressure in certain parts of the body.
- 4) Thermoregulation, the heat is transferred to other parts of the body via the circulatory system are.

Heat for flying

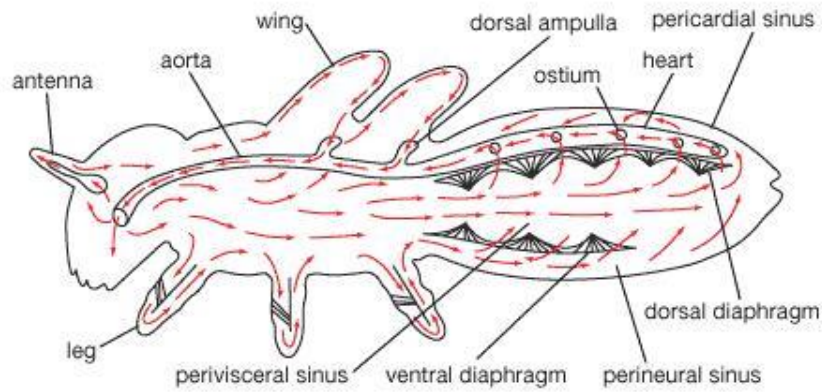
Heat for brooding eggs and larvae

Heat to kill predator

Heat for maintaining hive temperature in winter.

The Circulatory Path

Haemolymph from the body cavities enters the ostia when the alary muscles of the heart chambers relax. The alary muscles then contract to close the ostia and their valve-like structure prevents the haemolymph from returning to the body cavities. The haemolymph moves through the dorsal vessel by continual peristaltic contractions of the alary muscles. The contractions begin at the posterior chamber of the heart and continue forward, pushing the haemolymph anteriorly, toward the aorta the continual pumping pushes the haemolymph through the aorta and into the head, where it bathes the organs and muscles, and then flows back down the body via a series of cavities until it reaches the abdomen and re-enters the heart.

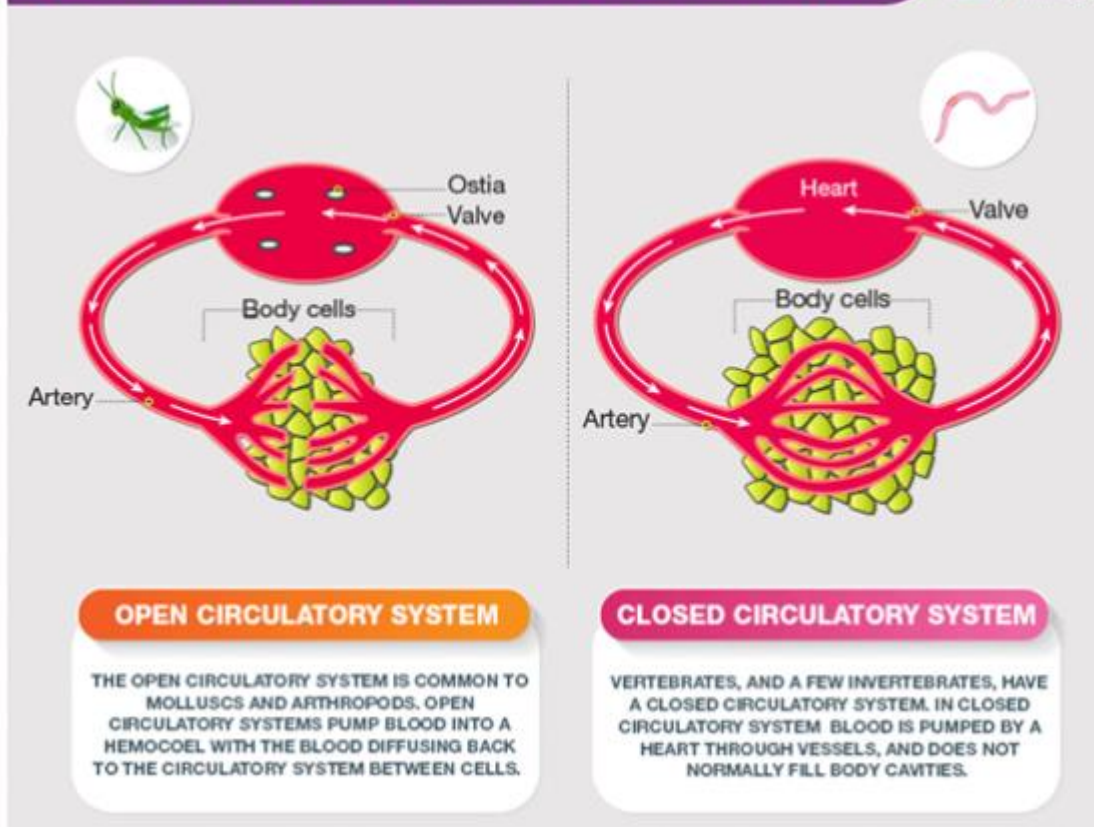


Difference between Open and Closed Circulatory System

Almost all multicellular organisms need a circulatory system to transport oxygen and nutrients through the body. Evolution has led to the existence of two types of circulatory systems, namely:

- **Open circulatory system:** It is primarily found in invertebrates. Here, the blood flows freely through cavities since there are no vessels to conduct the blood.
- **Closed circulatory system:** It is found in vertebrates and a few invertebrates, like earthworms. This system has vessels that conduct blood throughout the body.

OPEN AND CLOSED CIRCULATORY SYSTEM



The other major differences between open and closed circulatory system are summarized below:

Open Circulatory System	Closed Circulatory System
The hemolymph directly bathes the organs and tissues.	The blood circulates within closed vessels.
The blood and interstitial fluid cannot be distinguished.	Blood and interstitial fluid are distinct.
Present in <i>molluscs</i> and <i>arthropods</i> .	Present in <i>annelids</i> and vertebrates.
Blood is pumped into the body cavity.	Blood is pumped through the vessels by the heart.
Dorsal blood vessel present.	Dorsal and ventral blood vessels present.

Capillary system is absent.	Capillary system is present.
Blood is in direct contact with the surrounding tissues.	Blood is not in direct contact with the tissues.
Nutrients are exchanged directly between blood and tissues.	The nutrients are exchanged via tissue fluid.
No transport of gases.	Gases are transported.
The fluid flowing in this system is called hemolymph.	Fluid flowing in this system is called blood.
No respiratory pigments are present.	Respiratory pigments are present.
The volume of blood cannot be controlled.	The volume of blood can be controlled by the contraction and relaxation of blood vessels.
Blood flow is slow.	Blood flow is rapid.
The open spaces are called sinuses and lacunae.	Closed spaces involve arteries and veins.
Organisms with OCS: Snails, clams, cockroaches and spiders.	Organisms with CCS: Humans, squids, cats, earthworms.

Frequently Asked Questions

Q1

What is open and closed circulation?

In open circulation, the blood is not enclosed in the blood vessels and is pumped into a cavity called hemocoel. On the contrary, in closed circulation, the blood is pumped through the vessels separate from the interstitial fluid of the body.

Q2

What type of circulatory system do humans have?

Humans have a closed circulatory system. The blood is enclosed in the vessels and the heart while circulating. The blood travels through arteries and veins and carries important molecules throughout the body.

Q3

What is the advantage of a closed circulatory system over an open system?

In a closed circulatory system, blood is transferred faster than in an open circulatory system. That is why the closed circulatory system is more advantageous than the open system.

Q4

What are the main components of a (closed) circulatory system?

The main components of a (closed) circulatory system include:

- Heart
- Blood
- Blood vessels

Q5

Which organism has an open circulatory system?

Insects have an open circulatory system. Unlike humans, the blood in insects flows freely throughout the body.