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.

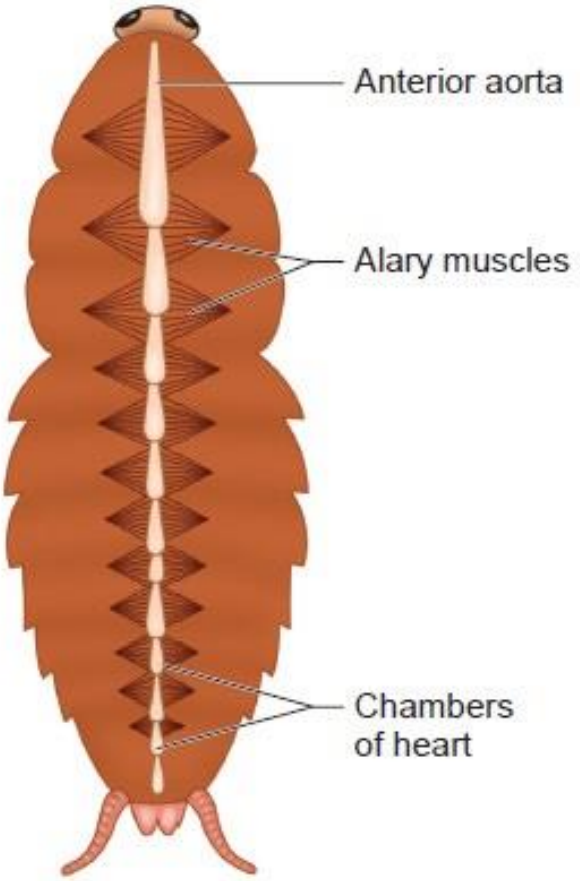
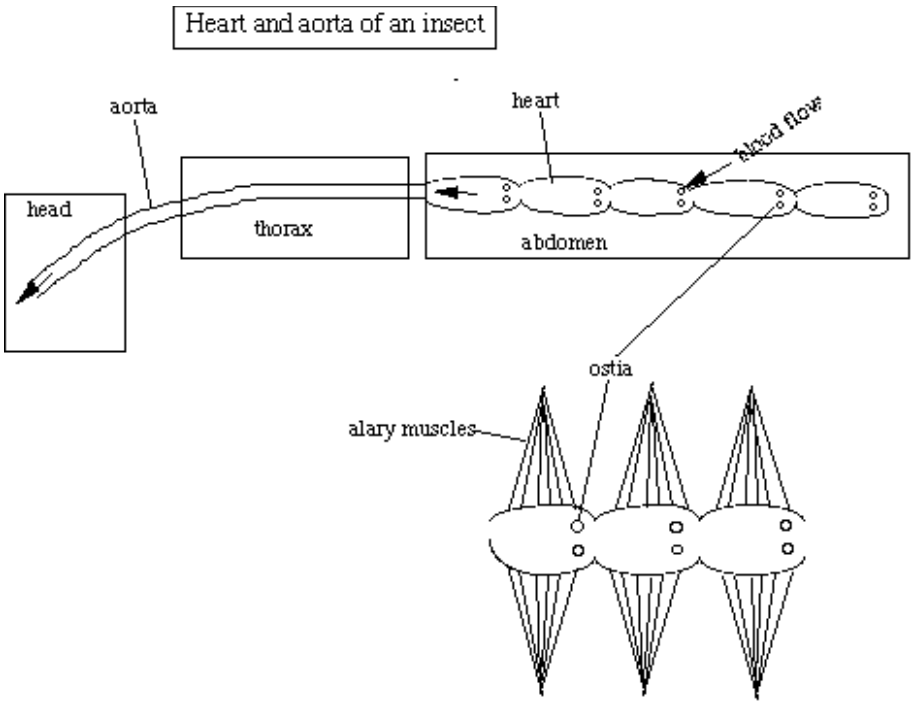


Fig. (1) Shows the parts of Circulatory system of Cockroaches



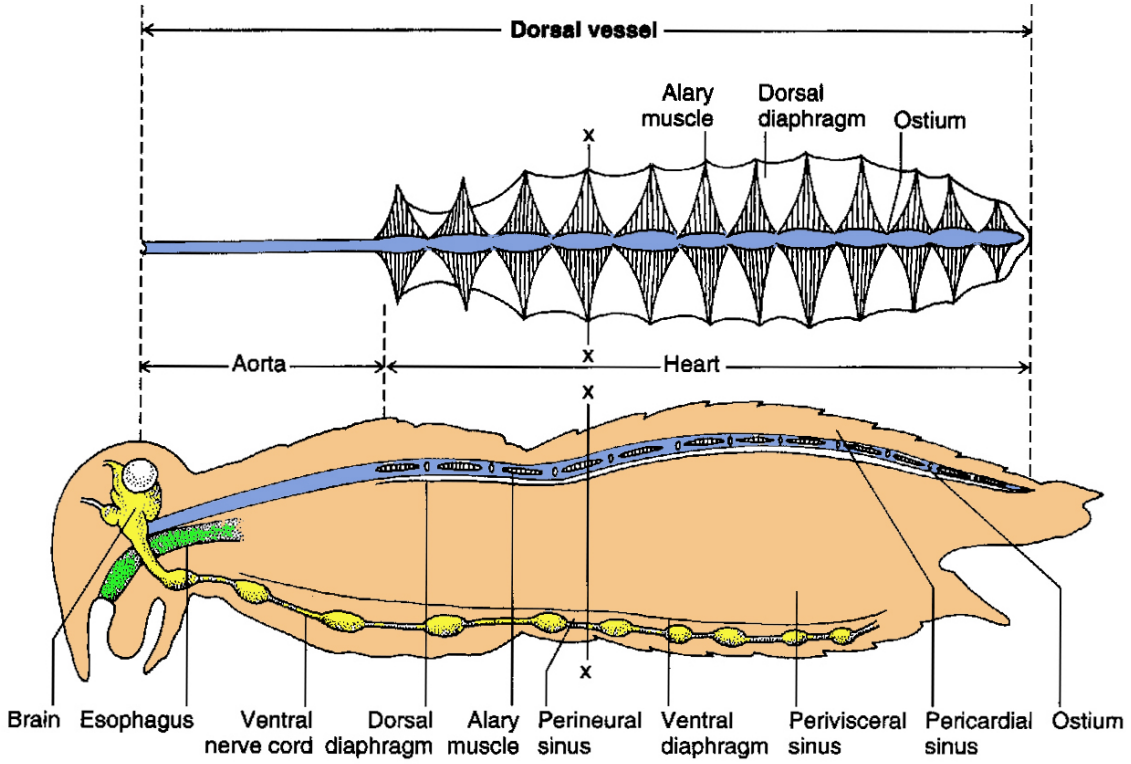


Fig. (2) Circulatory system of grasshoppers

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 hemocytes?

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-Granual leukocytes cells.

Functions of Circulatory system

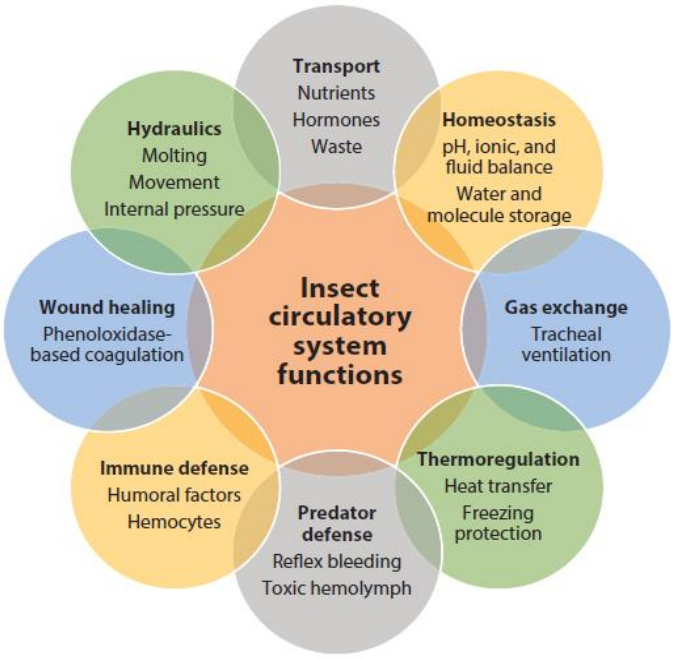


Figure 1

The many functions of the circulatory system of insects.

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

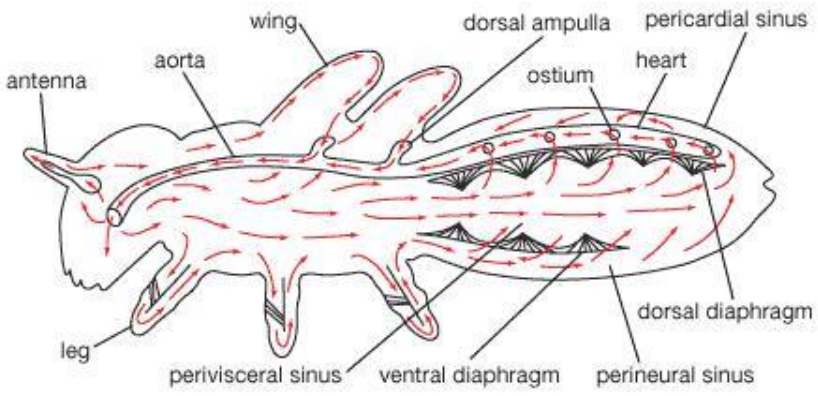
Heat for brooding eggs and larvae

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.



The difference between insect blood and the blood of vertebrates

The major difference between insect blood and the blood of vertebrates

1- Humans is that vertebrate blood contains **red blood cells.** Insects and other invertebrates, on the other hand, have what is called **hemolymph** heterogeneous fluid with yellow or green.
2- Unlike the closed circulatory system found in vertebrates, insects have an open system lacking arteries and veins.
3- The vertebrate circulatory system serves primarily to carry oxygen throughout the body.
4- Insects do have hearts that pump the hemolymph throughout their circulatory systems. Though these hearts are quite different from vertebrate hearts.