The function of the blood :

1- **Transportation:-**
   a- **Digested food .**
   b- **Waste product .**
   c- **Certain hormones .**
2- **Respiration :- some of the cells are not provided with tracheole for direct respiratory changes ; these cells obtain there O_2 from the dissolved store in the blood.**
   CO_2 diffuses through the tissues and finaly through the cuticle .
3- **Protection :- the hemocytes dispose of certain bacteria and parasite . the healing of the wounds is effected by the blood or its hemocytes .**
4- **Hydraulic function:- which use for many purposes:-**
   a- **The pressure of the blood is regulated by contractions of the thorax , abdomen or both , causes the emptying and filling of the tracheal air sacs and pouches .**
   b- **For stretching of the exoskeleton after moulting.**
   c- **It Is responsible for inflation of the wings and operating of egg hatching .**
5- **Storage : acts as a store of water.**

"The diaphragm and sinuses "

When the *diaphragm*s are completely developed , hemocoel is divided into three sinuses by means of two- fibro – muscular septa or diaphragms . The dorsal diaphragm is the septum most constantly present.

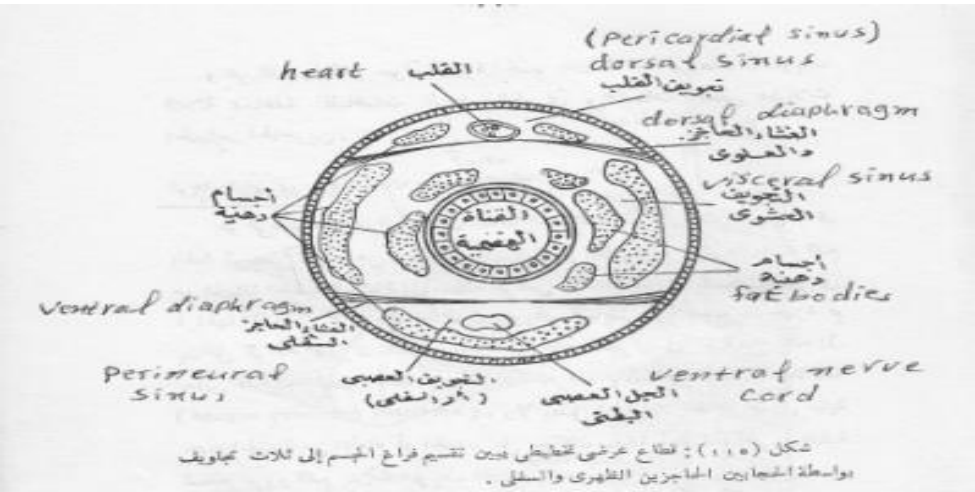
It extend across the abdominal cavity .

And in this way divides the hemocoel into a dorsal or pericardial sinus , containing the dorsal vessel , and a large visceral sinus , in some cases there is also a ventral diaphragm.

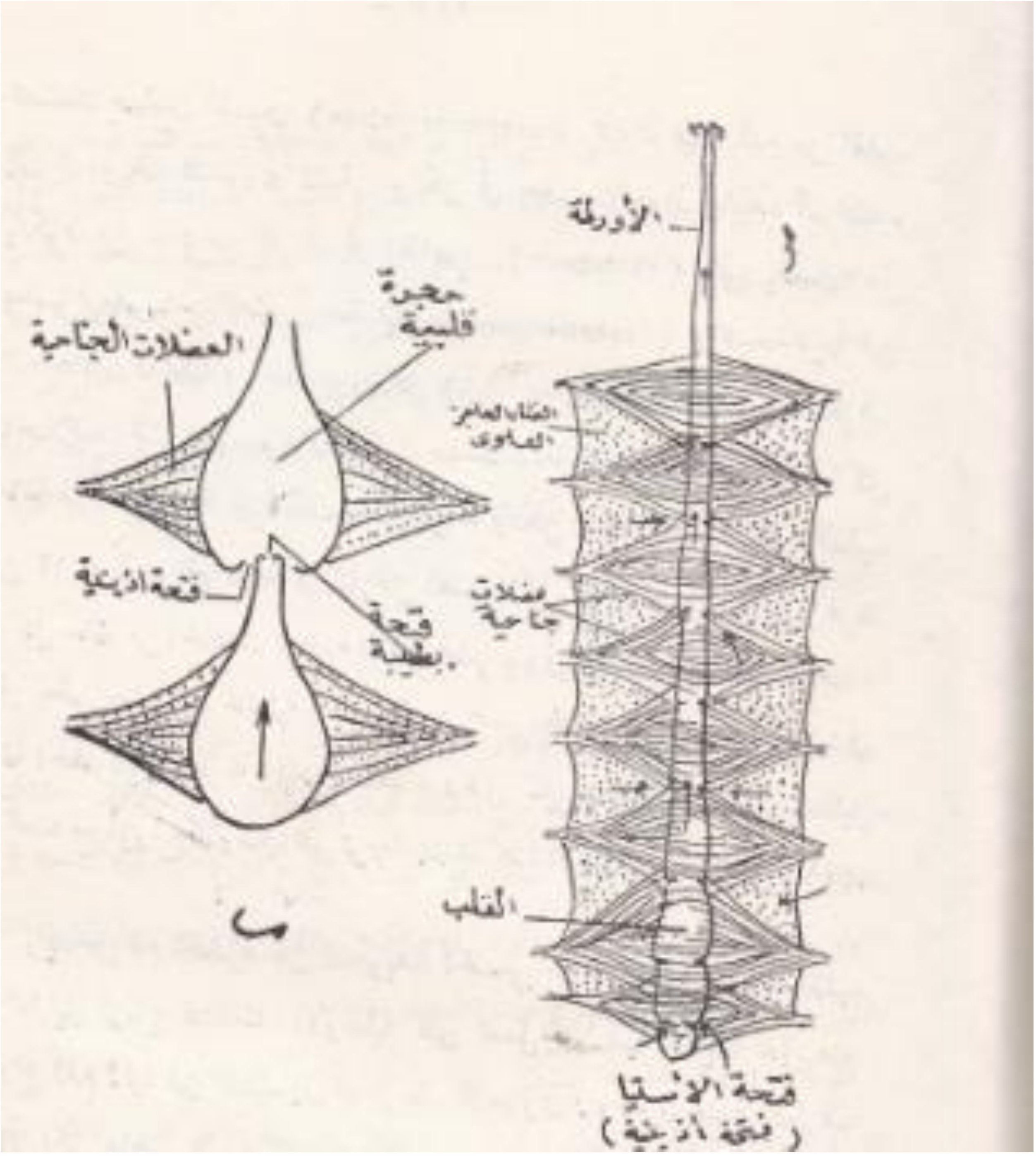
<u>Dorsal vessel :-</u> It is the main conducting organ of the circulatory system and is divided into the heart and the aorta .

<u>The heart</u> :- it is muscular contractile tube situated in median line of the <u>pericardial sinus</u> just above the dorsal diaphragm . As a rule it is a narrow continuous vessel whose sides are perforated with vertical slit-like opening or ostia , its margins may be inward to form the <u>auricular valve</u> which prevent the return of blood from the heart into the pericardial sinus .

The heart shows a series of dilations or <u>chambers</u> usually corresponding in number of the pairs of ostia and of <u>alary muscles .</u> There may be a chamber of the heart to each segments of the abdomen + to the second and third segment of the thorax . usually there <u>is ventricular valve</u> between the chambers .



شكل (١٠٥) : قطاع عرضى تخطيطى يبين تقسيم فراغ الجسم إلى ثلاث تجاويف بواسطة الحاجزين الظهرى والسفلى .



الأورطة
أ
حجيرة
قلبية
العضلات الجناحية
فتحة أذينية
فتحة
بطينية
ب
عضلات
جناحية
القلب
فتحة الأستيا
(فتحة أذينية)

The aorta :-

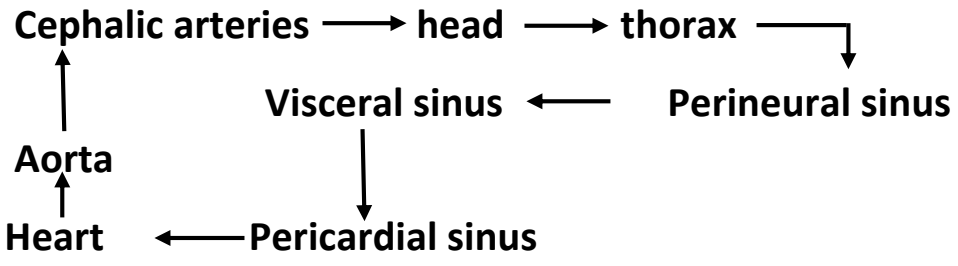
It is the anterior prolongation to the dorsal vessel , it is junction with the heart is marked by the presence of aortic valve , the aorta extends forward through the thorax to terminate in the head.

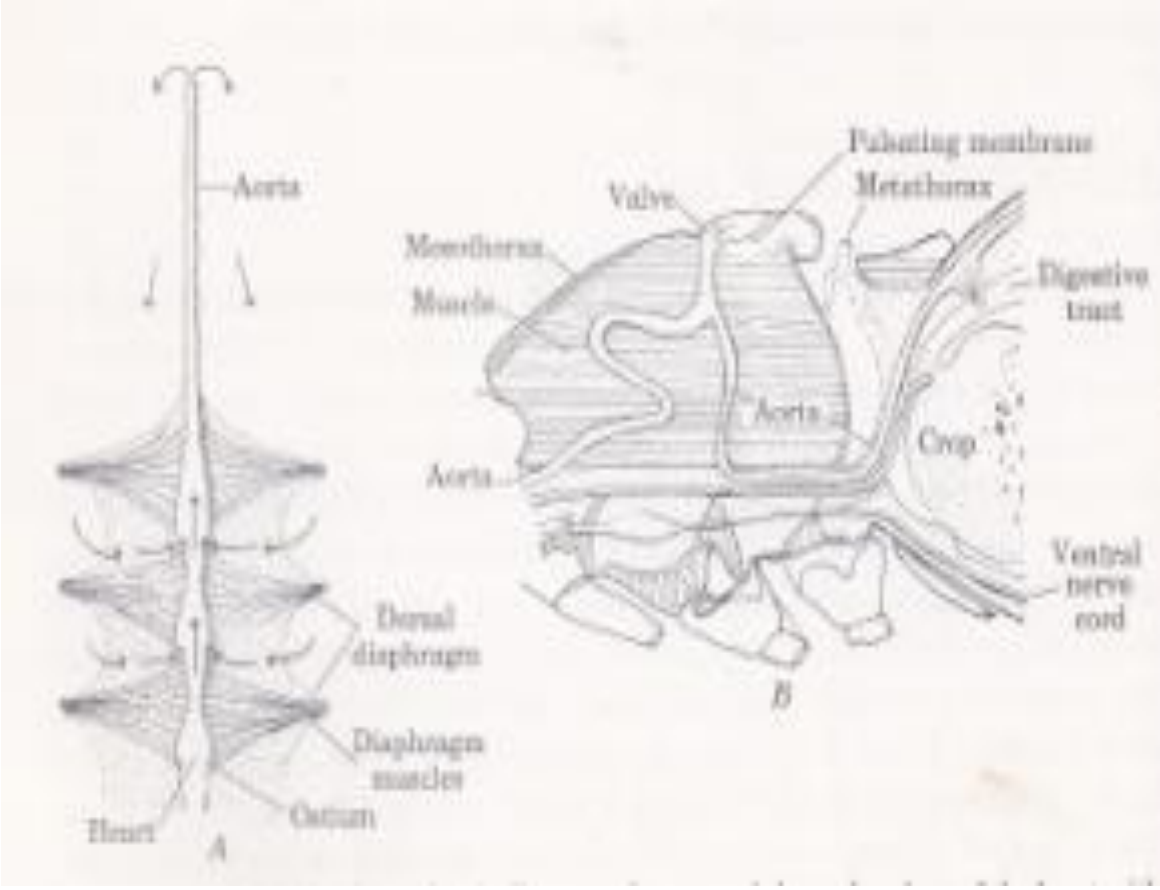
In some cases , its anterior extremity is an open funnel-like mouth but is divided into two or more cephalic arteries .

"Accessory pulsatory organs"

In addition to the heart accessory pulsatory organs have been described in many insects , they are sac-like structures situated in various regions of the body and pulsate independently of the heart , ensuring an adequate circulations of blood through the appendages . In some insects special pulsatile organs are present in leg; at the base of each antenna ; in the veins at the base of the wing .

The circulations of the hemolymph :- the heart is principles pulsatory organ and undergoes rhythmical contraction which are brought about by the muscle fibrils of its wall.





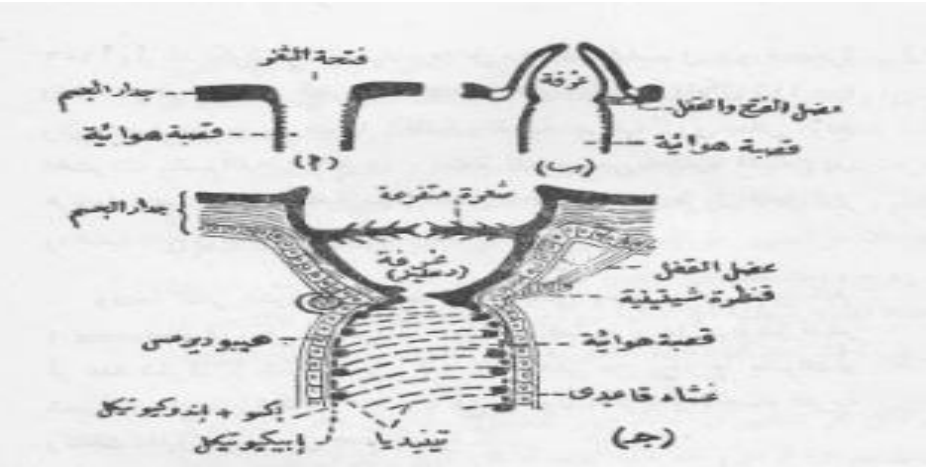
The pulsatory organ

"The Respiratory System"

In most of the insects there is no relationship between the hemolymph and the respiratory system. Hence the O_2 transvers . directly to the tissues via a group of tubes called <u>trachea</u> which subdivided into smaller and smaller tube called <u>tracheoles ,</u> which reaches to all tissue of the body . the air inters these tube by paired opening called <u>spiracles</u> or stigmata.

<u>The spiracles :-</u> **are paired opening sually situated on the pleura of the meso and metathorax and along the sides of the abdomen .**

<u>Structure of the spiracle</u> **:- the spiracle in its simplest form is a direct opening from the outside into a trachea , but generally the visible opening leads into a cavity (atrium) from which the trachea arise ,in the atrium there is one or more muscle with the associated cuticular parts by which closing of spircle opening occurs, prevent excessive loss of water vapor . The atrium lacks <u>taenidia</u> but provided with hairs , to reduce water loss and prevent the entry of dust , there is also <u>peristigmatic glands</u> which secret hydrophobic material preventing the drying of these organs.**



Structure of the spiracle

***The branching of the trachea*:-**

The trachea branching inside the body as one of the following :

1- **In some insects each spiracle leads to a trachea and branched in the organs of that segment.**
2- **The spiracle leads to anterior and posterior trachea , then reaches one another froming two tracheal trunks .**
3- **The tracheal trunks reaches one another by transvers trachea .**
4- **Or may be found two tracheal trunks on each side , one dorsal and another ventral .**

Type of Respiratory System

***(according to the number of the* functional spiracles)**

The number of the spiracles differs according to the insects group . some of them may be not functional or closed .

So we can classify Respiratory System into :-

1- **Holopneustic Respiratory System with 10 pairs of spiracle (2+8).**
2- **Hemipneustic Respiratory System : this type may be divided into :-**
   a- **Peripneustic R.S :- with (1+8) pairs .**
   b- **Amphipneustic R.S :- with (1+1) pairs .**
   c- **Propneustic R.S :- with one pair of spiracle on the prothorax**
   d- **Metapneustic R.S:- with one pair of spiracle at the end of the abdomen .**
3- **Apneustic Respiratory System :- with no functional spiracles . the air enters the body by diffusion or by tracheal gills or by body gills .**

Types of spiracles :- **many types of structural spiracles can be found in the insects :-**

1- ***Simple*** **spiracles *:-*** **they are just opening into the tracheal system , but not provided with mechanism for regulating its sizer .**
2- ***Fringed spiracles:-*** **these spiracles often have the atrial wall into branched hairs like process forming fillering apparatus.**
3- ***Lipped spiracles*** **:- it has a slit like opening guarded by two external valves or lips .**
4- ***Sieve*** **– plate spiracles*:-*** **the spiracles are circular , each consist of a crescent sieve plate and projecting tegumentary fold which is almost completely surround by it . the true opening is a curved slit situated near the margin of the bulla . it is found in the larvae of scarabeaidae .**
5- ***Sinous*** **spiracles :- in the larva of house fly the posterior spiracles of a pair cuticular plates . each plate is surrounded by a peritream and bears three openings in the form presenting the appearance of a grating , and the three openings communicate with a common atrium.**
6- ***Digitate*** **spiracles:- the anterior spiracles of house fly lavro consist of a variable number of digitate process with apices perforated by openings .**

"The trachea and trancheoles"

The *trachea* is elastic tube , they are lined by cuticle , this cuticle has a form of spiral thread or <u>taenidium</u>, the function of this thread is to keep the trachea distended and allow the free passage of air .

When trachea is followed in its branching it finally enters the cell and there divides into tracheoles .

The tracheoles end in the tissues in various ways :-

a- They branch and pass between the cells without penetrating them .
b- Or may enter the cell .
c- While in the flight muscles there is a network of intracellular tracheoles.

In typical segment, three principle trachea aries from the main longitudinal trunks , near the point where the spircular trachea joins it , these trachea are :-

1- Dorsal trachea .
2- Visceral trachea .
3- Ventral trachea .

The head and mouth parts are supplied by branches derived from anterior spiracle and dorsal longitudinal trunk.

"Air Sacs"

In many winged insects , the trachea are expanded to form thin – walled air sacs in which the taenidia are absent or poorly developed and often irregularly arranged.

Consequently, the air-sacs will collaps under pressure and they play a very important part in ventilation of the tracheal system as well as having other function.

The principle function of the air sac is a respiratory , as they serve to increase a surface area of trachea , the other function are ,these insects has a lower specific gravity , therefor make the flight easier of large specious . The air sac of the larvae of some insects act as hydrostatic organs, enabling the insects to float at any level in the water.

Respiration

In small terrestrial insects the oxygen passes along the tracheal system , from the spiracles to the finer tracheoles by the process of the gaseous diffusion , this is possible because of the difference in partial pressure of oxygen between the atmosphere and the tracheolar ending .