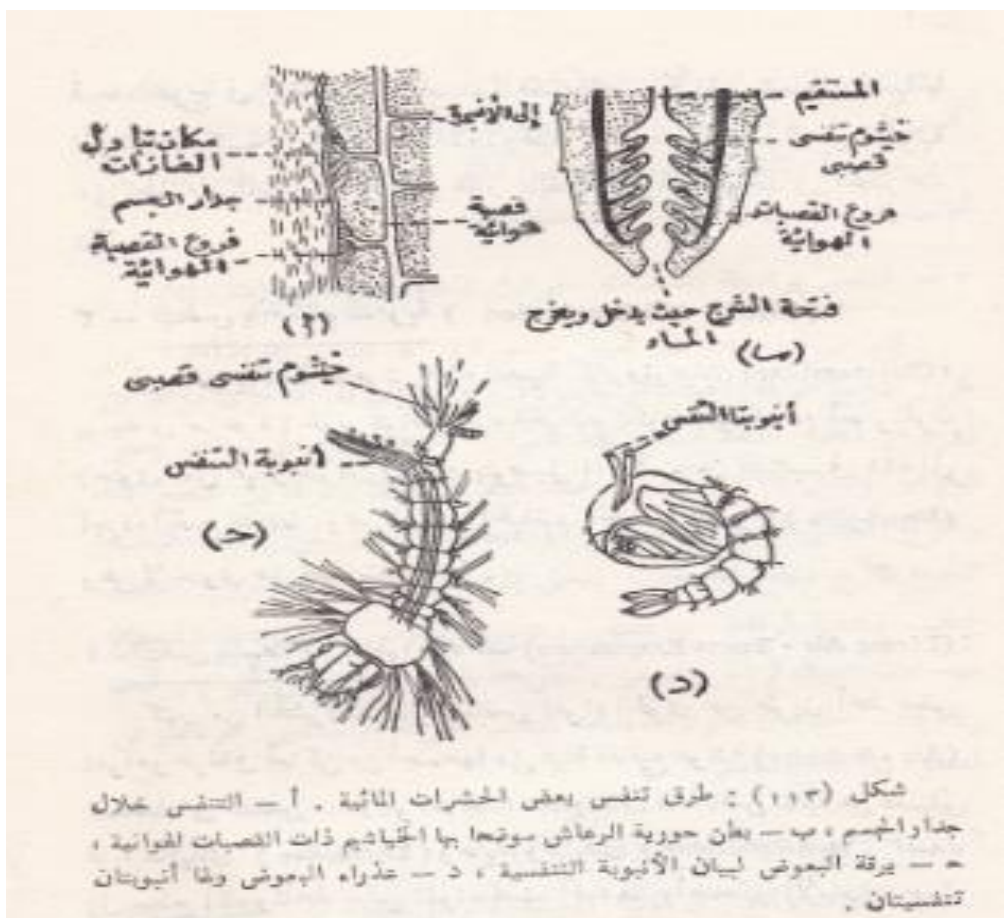


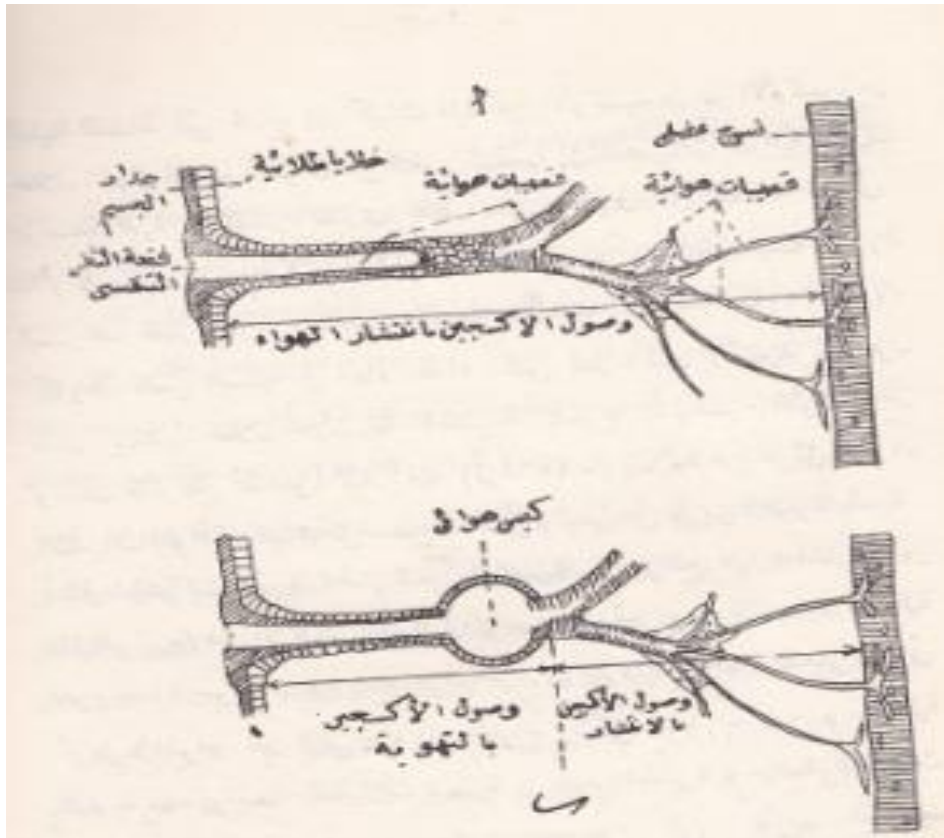
It is likely that much of CO₂ eliminated through the tracheal walls and the cuticle of the body surface rather than through the spiracles.

"Gas Exchange in Aquatic Insects"

There are many kind of Aquatic insects spend its whole life cycle in the water , have an open tracheal system and obtain O₂ from atmosphere through one or two pairs of spiracles , in others the tracheal system is closed and O₂ diffusion into the water through the following :-

- 1- Cutaneous respiration.
- 2- Air tubes (larva and pupa of mosquito).
- 3- Air stores (diving beetles)
- 4- Tracheal gills (may fly)
- 5- Blood gills (Chironomidea).





Gas exchange

"The muscular system"

Most of the insect muscles are striated whether they are voluntary or involuntary , they are transparent , white or grey.

One end of the voluntary muscle connect it with immobile part of the skeleton , called the origin , and the other end of it connect with moved part called the insection .

The important muscles of the insect are :-

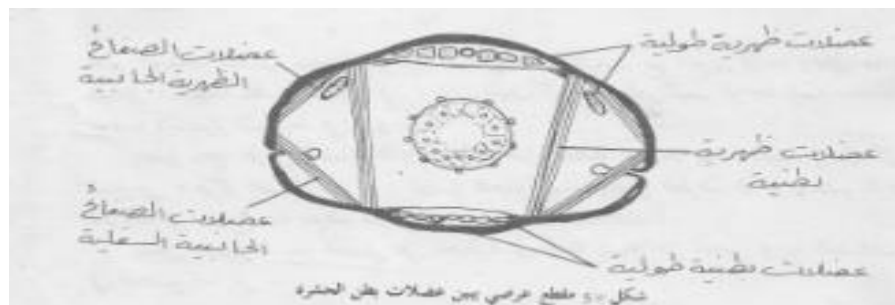
1- The abdominal muscles:

- a- They are longitudinal either tergal or sternal muscles ,with the contraction of tergal muscle the abdomen curved and the contraction of the sternal muscle the abdomen bent down .
- b- Dorso-ventral muscles : they are tergal and sternal reach between tergum and the sternum , it help in respiration .
- c- Pleural muscles : they origin from the tergum or the sternum and connect it with the pleuron , it help in respiration , open or close of the spiracles .

2- The thoracic muscles : they are either :

- a- Longitudinal muscles .
- b- Dorso – ventral muscle
These muscle move the leg or rise and lower the tergum .
- c- The leg muscles :- inside the leg parts .

3- Head muscle :- for the neck , mouthparts , and antenna .



"Excretory system"

The function of the Excretory system is the maintenance of a relatively constant environment for the tissues and the body, by the eliminations of the nitrogenous waste-products of proteins breakdown and the control of the ionic composition of the hemolymph.

The principle Excretory organs are :-

- 1- Malpighian tubules .
- 2- The integument .
- 3- wall of the alimentary canal .
- 4- Nephrocytes.
- 5- Fat body .

"The integument as an Excretory organ"

- 1- with the exuviae the insects loses N,Ca and pigments.
- 2- By respiration, through some part of the ectoderm the insects eliminate CO₂ and water .
- 3- In the insects with rudimentary or closed tracheal system respire directly complete through integument .

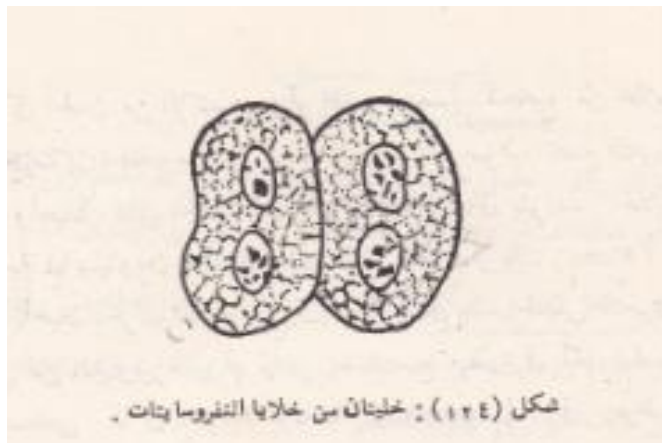
"Excretion through the wall of the alimentary canal"

In the wall of midgut, observed accumulation of crystalline bodies as salts of calcium, the insect make little use of calcium in its body structures. Analysis of faeces always show a high percentage of Ca.

"The nephrocytes"

they are large cells with two nuclei found in the hemolymph . these cells absorb the colloid material and other pigments and change it to crystalloid material and exert it to the hemolymph , then to Malpighian tubules .

These cells found in the dorsal sinus so they called pericardial cells or storage kidney .



Fat bodies

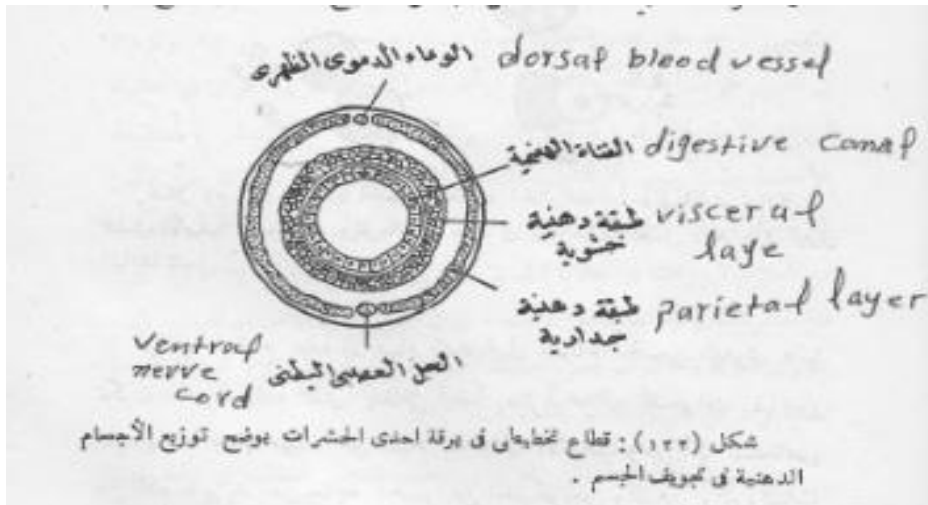
The fat bodies is present in all insects , generally there is:-

- 1- Visceral layer around the gut .
- 2- Parietal or peripheral layer beneath the integument.

Its main function is to synthesise and store of reserve materials which can be mobilised as required .

The fat body also perform an excretory function . In some insects special excretory cells containing deposits of urate are present among the ordinary cell of the tissue , these cells act for storage until their products are eliminated at the time of pupation , in the insects which lack Malpighian

tubules , urate concretions are deposited and increase in size throughout life.



Malpighian tubules

There are almost universally present among insects. They are long , slender , blind tubules lying in the hemocoel and freely bathed by the blood , they open at their proximal extremities into the intestine , near the junction of the hind gut with the mid gut . distally they are usually free , but in some insects , the distal ends of the tubules are closely applied to the hind gut (cryptonephridia).

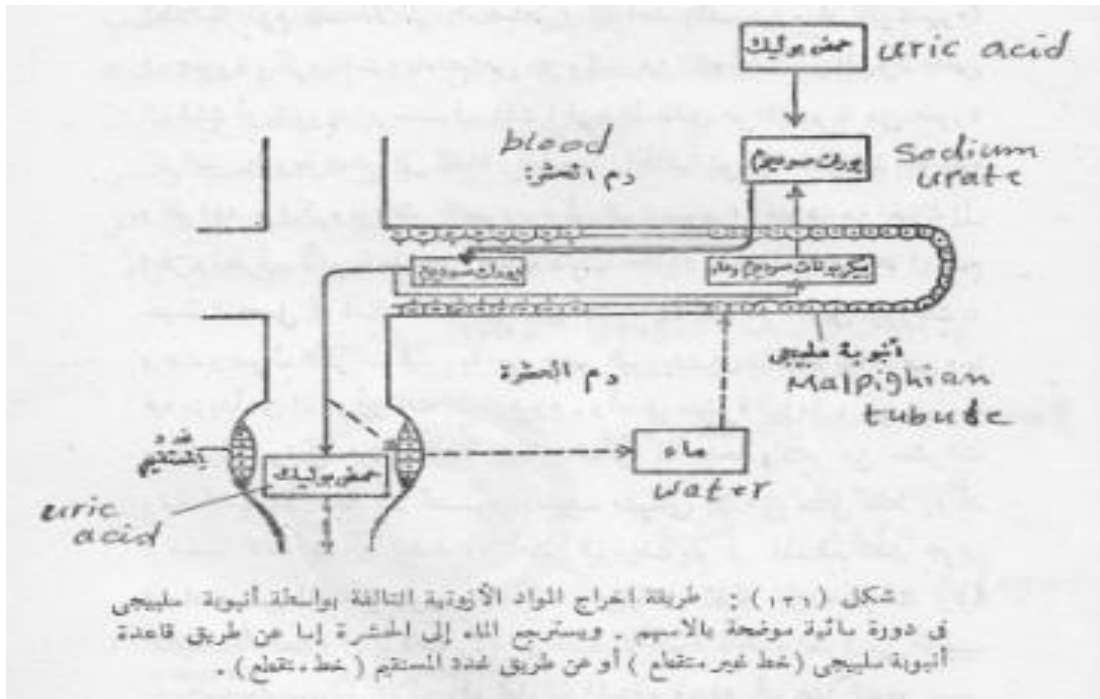
Cryptonephry enables the insect to conserve water by with drawing it from the feces .

These vessels usually occur in twos or multiple.

The function of Malpighian tubules

Malpighian tubules remove excretory materials from the blood in the form of urine , which is secreted into the lumen of the tubules and ultimately discharged into the hind gut .

the principle nitrogenous material is uric acid or as Na,K salts , other excretory product include Ca salts , that are sometime taken into the body in quantities greatly above requirement ; the most general compound is CaCO_3 which is usually stored during larval life , and often used in various ways during metamorphosis .



Other functions of the Malpighian tubules are :-

- a- *Secretion scales in some insects (Cercopidae)*
- b- *Larvae of some Neuroptera secrete the silk from which the pupal cocoon is constructed.*

"The nervous system"

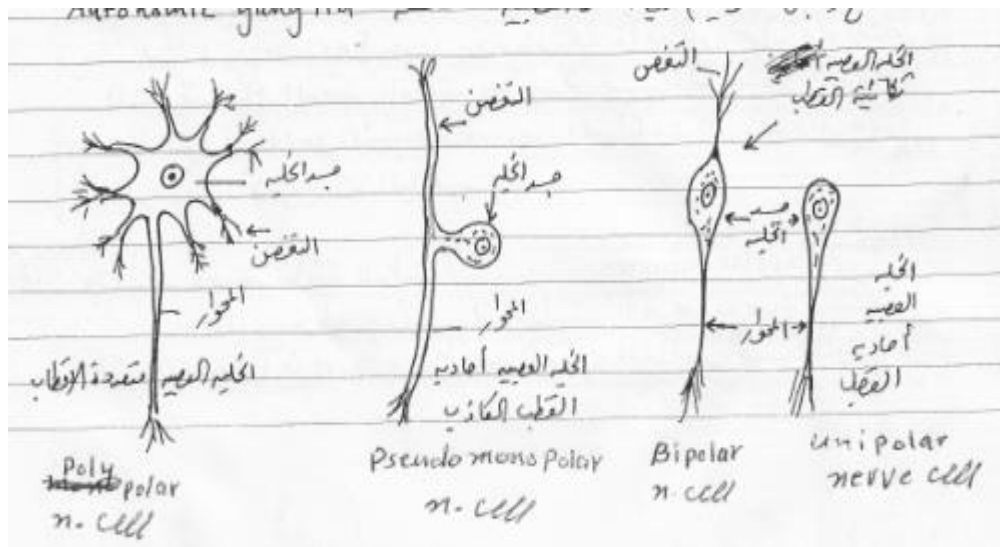
The nervous system serves as an elaborate connecting link between the sense organ which respond to the diverse stimuli provided by the environment. the nervous tissue compriiser of :

- a- Neuron (nerve cells).
- b- Neuroglia (interstitial cells).

The neuron consist of cell body with its nucleus and one more axon .

According to the axons a neuron described into :-

- 1- Unipolar.
- 2- Bipolar.
- 3- Multipolar.



Each axon is inclosed by the neurilemma (no myelin sheath) .

The axon has a side branch end in delicate branching fibrils (terminal arborization) ,three kinds of neurons occur commonly :-

- 1- **The sensory neurons** :- bipolar – associated with the sense organs and lie near the integument, and never found within the central nervous system .
- 2- **The motor neurons** :- always lie within the ganglia- mostly unipolar . there axons pass mostly to the muscles .
- 3- **The association neurons** :- form , with their process links between the sensory and motor neurons . The resulting junction between the arborization of adjacent nerve cells are known synapses.

The terminal branches of two neurons are not usually in actual contact at a synapse ; each nerve impulse which arrives there causes the temporary release of a transmitter substance such acety choline or γ -amino butyric acid which then activates the adjacent neuron , so insuring transmission of the impulse across the synapse .

The nervous system comprises of :-

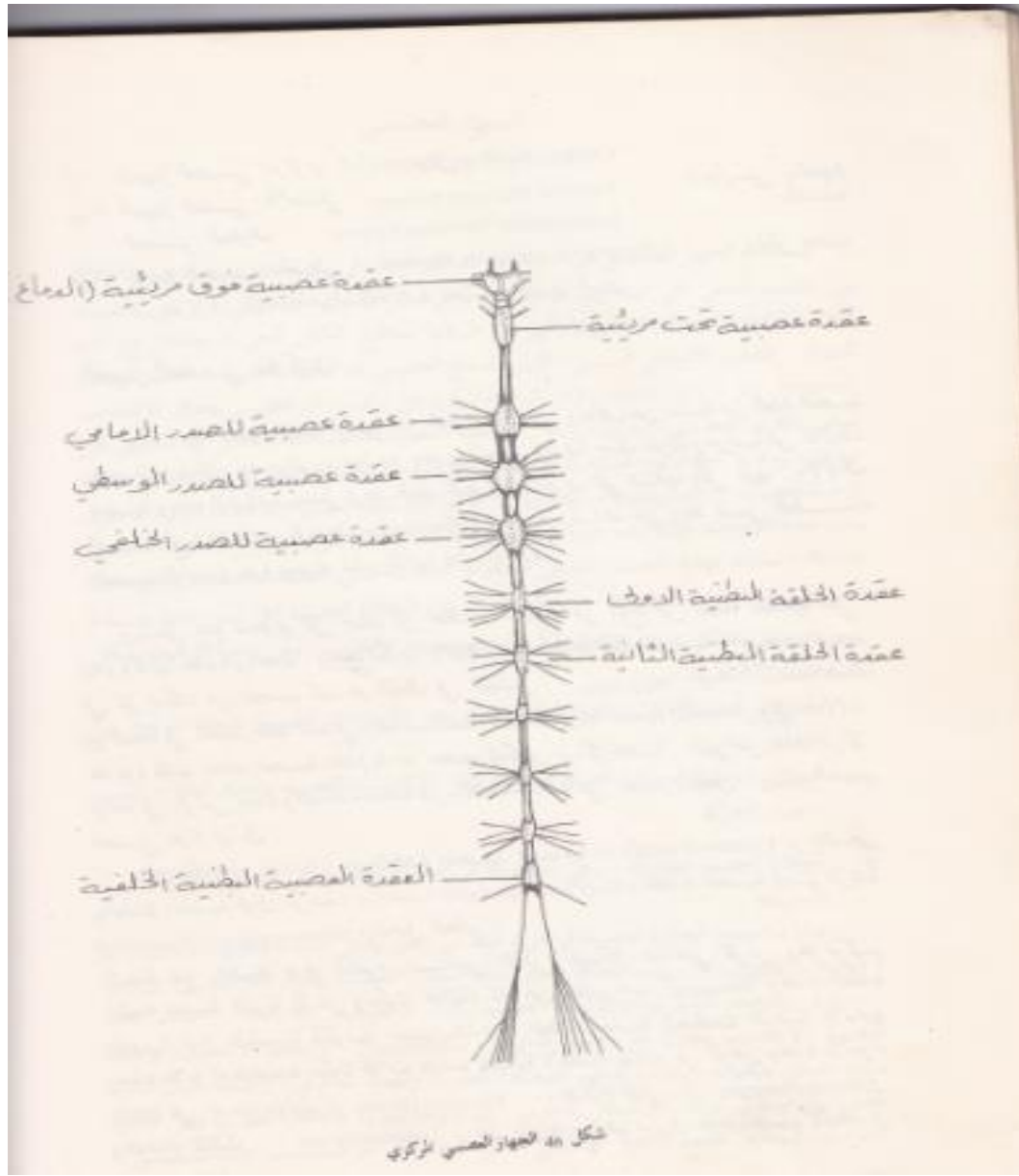
- 1- Central nervous system .
- 2- Sympathetic nervous system.
- 3- Peripheral nervous system.

The Central nervous system

This is composed of a double series of nervous ganglia , joined together by longitudinal and transverse tracts of nerve fiber , the longitudinal tracts of fibers are the connectives , which connect the ganglia of one pair . there is a pair of ganglia in almost every segment in the lower insects ; a varying degree of fusion occurs in the higher groups.

The central nervous system is divisible into:-

- 1- the brain .
- 2- subesophageal ganglia.
- 3- The ventral nerve cord.



1- The Brain (supra esophageal ganlion)

Its lies above the esophagous and is formed by the fusion of three pairs of ganglia of the first three segments, and give rise :-