

~~Nitrogenous (uric acid) waste metabolites transported from haemolymph by Malpighian tubules into lumen (M). → Then after selective reabsorption, excreted out of body.~~

use as evaginations from the anterior end of the hindgut. They extend anteriorly and posteriorly around the gut. The fat bodies are yellow or white masses of cells surrounding the gut. The principal function of the fat bodies is to store the food reserves like fat, glycogen and protein but they also carry out the excretory function. Insects are uricotelic. ($\text{NH}_3 \rightarrow \text{UA}$ highly insoluble comp.)

3. Reproductive system: It should be studied separately in male and female sexes.

The male reproductive system (Fig. 28) consists of a pair of testes (sing. testis). These testes are closely associated into a single yellow structure which generally lies on the midgut of the alimentary canal. Give a longitudinal cut with a blade along its mid-dorsal line to separate it into two parts. Each testis is composed of a large number of tubular testicular follicles. Each follicle opens by means of a short, slender duct, the vas efferens (pl. vasa efferentia) into the long genital duct or vas deferens (pl. vasa deferentia). The follicles are attached to the body wall by a suspensory ligament. The vasa deferentia run posteriorly to open into a wider tube, the ejaculatory duct, below the ventral nerve cord. Just anterior to the points of opening of vasa deferentia, two groups of long tubular accessory glands also open into the ejaculatory duct. A medial pair of these glands becomes fairly dilated to serve as seminal vesicles (vesiculae seminales) for storing the sperms. The ejaculatory duct opens posteriorly into a large pouch-like structure, the ejaculatory sac which opens into the aedeagus (part of external genitalia).

The female reproductive system (Fig. 29) consists of a pair of ovaries. These ovaries are closely associated into a single body which lies on the midgut and a part of the hindgut. Also separate it into two component parts by giving a longitudinal cut along its mid-dorsal line. Each ovary is composed of a large number of tubular ovarioles which arise from the side of the oviduct. The ovarioles end in thread-like filaments which unite to form a suspensory ligament by which they are attached to the body wall. The oviducts also extend anteriorly to form two accessory glands. Then the oviducts run posteriorly and after making a short bend unite into a fairly dilated common oviduct (vagina) below the ventral nerve cord. The vagina terminates in the genital chamber. The spermatheca is a sac-like oval body which receives and stores the sperms. It opens by means of a coiled spermathecal duct into the genital chamber. The latter ends into an egg-guide which is situated between the ventral valves of the ovipositor (part of external genitalia).

4. Circulatory system: It consists of the dorsal blood vessel and the accessory pulsating organs present at the bases of appendages. The circulatory system in insects is an open one, i.e., there are no arteries and veins (except the single dorsal blood vessel) and the blood circulates freely in the body cavity, the haemocoel. The latter has two longitudinal diaphragms (partitions) of membranous connective tissue: the dorsal and the ventral diaphragms. These diaphragms divide the body cavity into three sinuses: the dorsal (pericardial) sinus, the large central (perivisceral) sinus and the ventral (perineural) sinus.

The dorsal blood vessel (Fig. 30) lies along the midline in the pericardial sinus just below the body wall. It is a long, straight, white tube extending from the head to the 10th abdominal segment. It consists of two parts. The posterior part that lies in the abdomen is called the heart. It becomes segmentally dilated to form chambers (ampullae) which are provided with paired dorsolateral openings, the ostia (sing. ostium) having valves in them. The heart tapers posteriorly and ends blindly in the 10th segment. Eight pairs of alary muscles

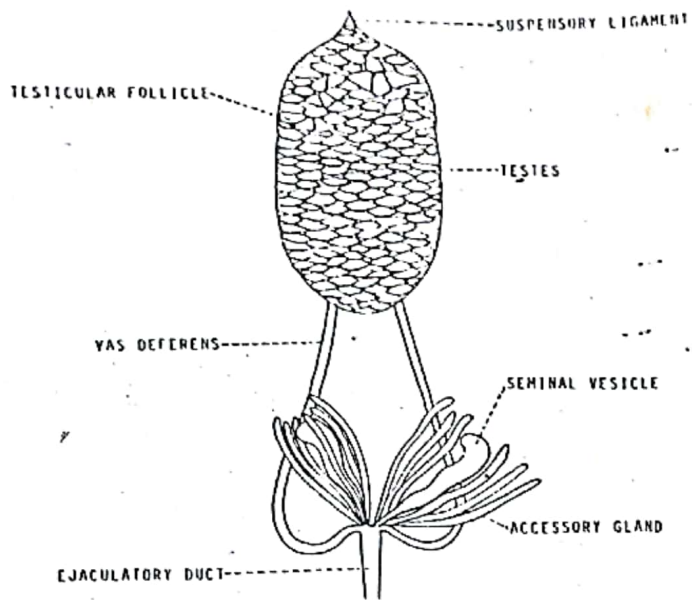


FIG. 28. REPRODUCTIVE SYSTEM OF MALE AK GRASSHOPPER

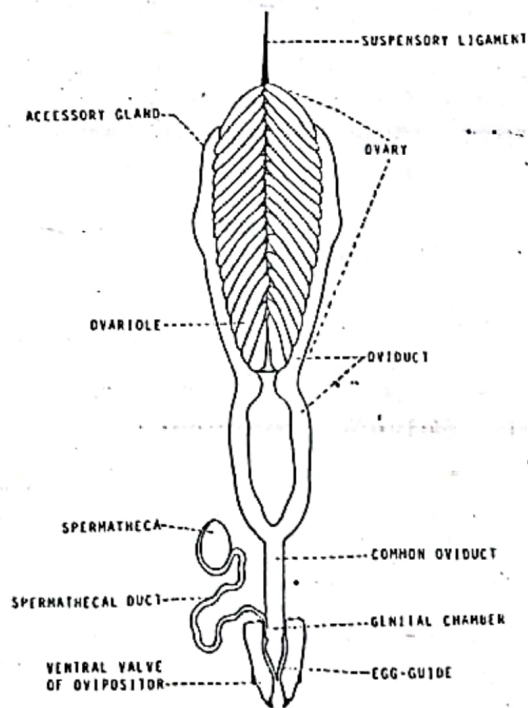


FIG. 29. REPRODUCTIVE SYSTEM OF FEMALE AK GRASSHOPPER

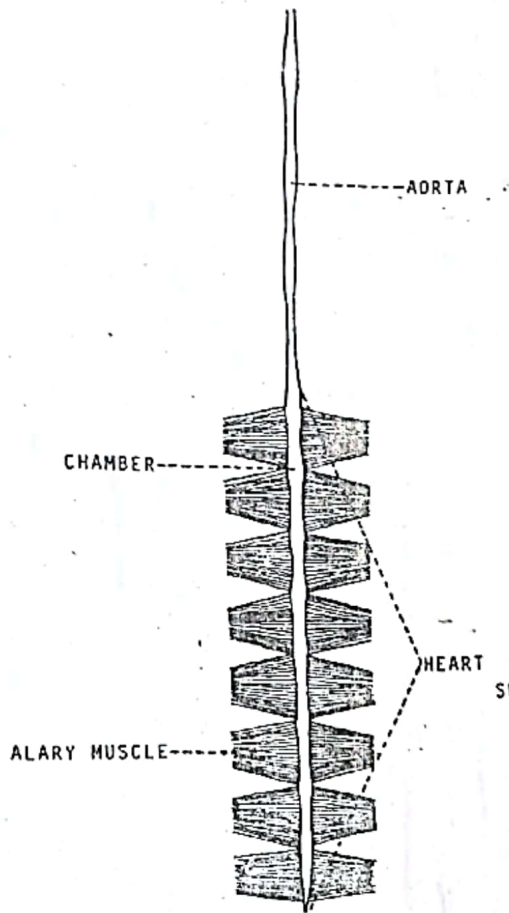


FIG.30. DORSAL BLOOD VESSEL OF AK GRASSHOPPER

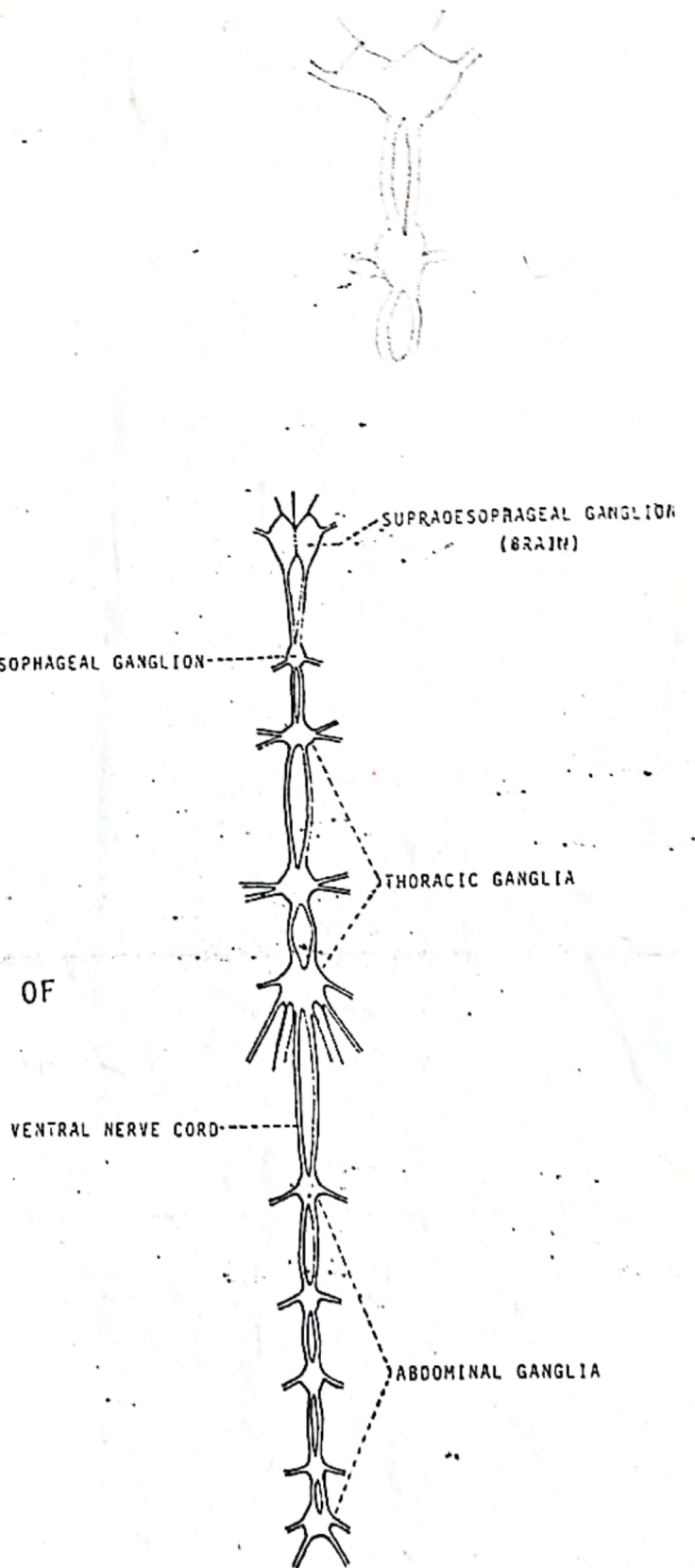


FIG.31. CENTRAL NERVOUS SYSTEM OF AK GRASSHOPPER

which arise from the sides meet broadly beneath the heart. The anterior part that lies in the thorax and head is called the aorta. It is a delicate tube which is slightly dilated at three places. It ends near the brain. The blood (haemolymph) enters the heart through ostia from the haemocoel, carried anteriorly in the heart and aorta, and again returned to the haemocoel in the head.

5. Nervous system: It is divided into the following three divisions:

(a) Central nervous system: It is the main division and consists of the supraoesophageal ganglion (brain), suboesophageal ganglion and the ganglionated ventral nerve cord.

(b) Peripheral nervous system: It consists of the nerves that connect the central nervous system with the peripheral sense receptors (sense organs).

(c) Visceral or sympathetic nervous system: It consists of the nerves and ganglia that connect the central nervous system with the viscera (different organs in the body such as gut, heart, reproductive organs, etc.).

For this introductory course, only the central nervous system will be dissected and studied. It lies in the median line of the body below the alimentary canal except the brain which is dorsal to it. It extends from the head to the eighth abdominal segment. For clearing the central nervous system, remove the ventral diaphragm carefully with the help of fine forceps and a dissecting needle. Now trace the ventral nerve cord and proceed towards the head. The central nervous system (Fig. 31) consists of a large compound ganglion (pl. ganglia) known as supraoesophageal ganglion (brain) which lies in the head above the oesophagus. The brain (when seen under high magnification) is further differentiated into three pairs of lobes: protocerebrum (fore brain), deutocerebrum (mid brain) and tritocerebrum (hind brain). The brain is connected with the suboesophageal ganglion which lies in the head below the oesophagus. It is connected with a ventral nerve cord which has three thoracic and five abdominal ganglia. The last ganglion is the composite one and biggest of all the abdominal ganglia.

The ganglion of one segment is connected with that of an other by means of paired connectives. In each segment there are actually two ganglia which are transversely connected by means of commissures and fused into a single ganglion. All ganglia innervate (i.e. supply nerves) to the different body sclerites or organs.

6. Respiratory system: It consists of paired lateral spiracles, tracheae and tracheoles. The spiracles are the external openings through which the air enters and leaves the body. They can be closed because they are provided with a closing mechanism. The grasshopper has 10 pairs of spiracles, two thoracic (one between the prothorax and mesothorax and the other between the mesothorax and metathorax -- Fig. 16B) and eight abdominal (one on each of the first eight abdominal segments -- Fig. 17A). The spiracles open into elastic internal tubes, the tracheae (sing. trachea). The tracheae from the adjoining spiracles unite to form longitudinal trunks. There are six longitudinal trunks, two dorsal, two ventral and two lateral. When the grasshopper is dorsally dissected and the two flaps are brought on sides and pinned, one dorsal trunk goes on each side as shown in Fig. 32. The two ovaries are united into a single body which lies on the alimentary canal in the abdominal segments 3-5. One lateral trunk is located on each side of this body, while the two

Tracheae have a wall of single layered epithelial cells
cells secrete cuticular thickening around the tube that have
a wall of that give support the tubes