

Digestive System of Grasshopper

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Grasshopper is an invertebrate animal. It belongs to the phylum Arthropoda and class Insecta. The characteristics of grasshopper are like other insects. Grasshopper lives all over the world in grassland and leafy vegetation. They feed on grass and leaf. Some kinds of grasshoppers are known as locusts.

Classification of Grasshopper

Kingdom: Animalia
Phylum: Arthropoda
Class: Insecta
Order: Orthoptera
Family: Locustidae
Genus: Schistocera
Species: *S. gregaria*

External Features

1. Grasshopper's body is narrow, elongated, tubular and somewhat compressed laterally. It is about 8 cm in length.
2. Its body is yellowish gray that enables them to resemble the environment in which they live.
3. Entire body is covered by a hard cuticle or integument, cuticle is divided into a definite number of segments.
4. The body of Grasshopper is divided into head, thorax and abdomen.

A. Head: The head is big and somewhat triangular. There is a pair of large compound eyes and a pair of antenna on the head. At the anterior end of head there is a mouth opening. Surrounding the mouth opening there are some mouth appendages.

B. Thorax: There are three pairs of segmented legs on the ventral side and two pairs of elongated wings on the dorsal side. The fore wings are a bit thicker and the hind wings are broad and membranous.

C. Abdomen : Abdomen of grasshopper is elongated and gradually narrow towards the posterior end. The posterior end of abdomen bears a pair of out growth known as anal cerci. On the two sides of body eight pairs of respiratory openings called spiracles are present.

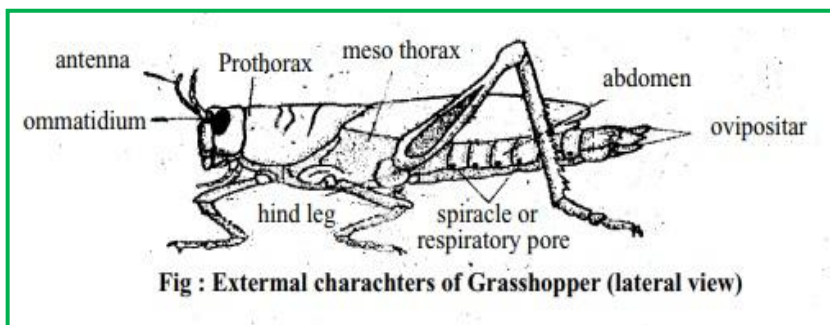


Fig : External characters of Grasshopper (lateral view)

It includes the organs of ingestion (alimentary canal and its associated glands) and the physiology of digestion. The organs of ingestion are located in the head and are meant for the intake of food. They constitute the mouth parts which have already been described earlier.

The preoral cavity is enclosed by the mouth parts and is divided into two parts by the hypopharynx, the anterior region in which the alimentary canal opens is termed as cibarium where in the salivary duct opens is known as salivarium. In the sucking insects the cibarium is modified into a sucking pump while salivarium serves as the salivary syringe. In larval Lepidoptera the silk - press is also a modification of salivarium.

• **Alimentary canal:** The alimentary canal of grasshopper is a simple, hollow and tubular in structure which runs from the buccal cavity to anus. It is distinctly divided into the following three primary regions:

1. Foregut or stomodaeum.
2. Midgut or mesenteron or ventriculus
3. Hindgut or proctodaeum.

1. Foregut or Stomodaeum: It constitutes the anterior region of alimentary canal which is primarily an organ of ingestion and serves as a site for storing food. It consists of the following parts:

(i) **Pre - oral food cavity** - It has been described previously and indeed it is not a part of alimentary canal .

(ii) **Pharynx** - It is situated in between the pre - oral cavity and the oesophagus and is provided by the dilator muscles . These muscles are highly developed in those insects in which pharynx helps in forming the sucking pump.

(iii) **Oesophagus** - It is a simple straight tube which runs from the posterior region of the head to throat and joins with the crop .

(iv) **Crop** - It is simple , bag like structure and serves as a storage reservoir for the food . Apparently, it is a dilated portion of the oesophagus but differs histologically by the presence of sclerotized ridges which are arranged transversely in the crop. Since it serves as a reservoir for food, hence its walls are thin and the muscles are poorly developed.

(v) **Gizzard** - It is situated in the posterior region of the crop which can not be apparently distinguished from crop , but differs internally by having the longitudinal folds into the lumen in which cuticular teeth are attached . Its ' posterior part is concentric which internal layer of six ' V ' shaped processes is attached which form the cardiac valve with the folds of gizzard. Its major function is to regulate the passage of food into the midgut.

Histological, the following layers may be distinguished in the walls of the stomodaeum:

- (1) **Intima** - The innermost layer of chitin is found in continuation of body cuticle .
- (2) **Epithelial layer** - It is a thin layer secreting the intima .
- (3) **Basement membrane** - Bounding the outermost surface of the epithelium .
- (4) **Longitudinal muscles** - These muscles are less developed than circulatory muscles
- (5) **Circulatory muscles** - These are well developed .
- (6) **Peritoneal membrane** - It is often difficult to detect and consists of apparently structure less connective tissues .

2. Midgut or Mesenteron: It is relatively a short tube or elongated sac with uniform diameter and extends from hepatic caecae or cardiac valve to Malpighian tubes or pyloric valve. Histologically, the Inner wall of mesenteron or stomach is not made up of chitin, but consists of following layers:

- (i) Peritrophic membrane
- (ii) Basement membrane
- (iii) Enteric epithelium

- (iv) Circular muscles
- (v) Longitudinal muscles
- (vi) Peritoneal membrane

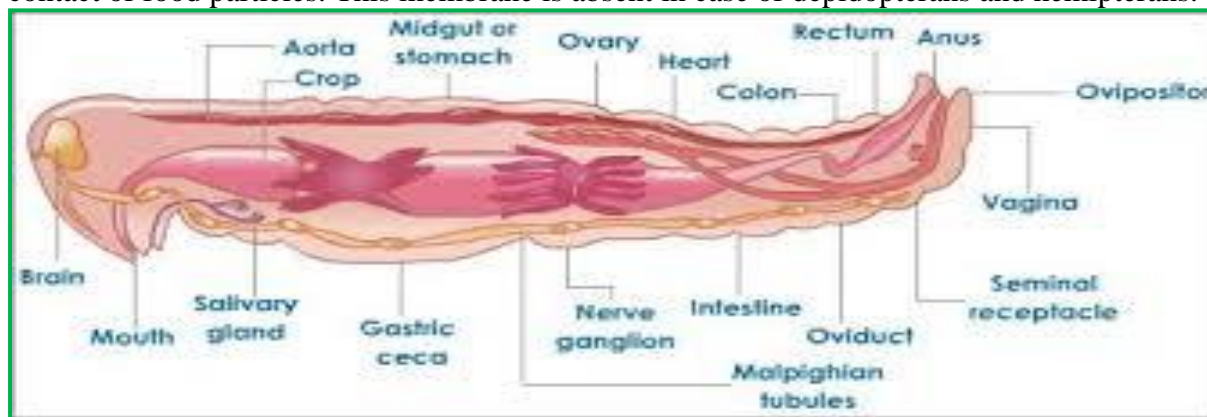
The enteric epithelium is made up of three types of cells:

- i. The columnar cells which secrete the enzymes and absorb the digested food .
- ii. The regenerative cells which renew the destroyed and dead epithelial cells through secretion or in the process of degeneration.
- iii. The goblet cells which are of uncertain functions.

Thus, there are following five major functions of enteric epithelium

- To make digestive enzymes.
- To produce new cells.
- To excrete the waste material outside the body.
- To absorb the water.
- To absorb the digested food.

The inner surface of midgut is sometime lined by a thin membrane known as peritrophic membrane and the main function of which is to protect the epithelial cells from the direct contact of food particles. This membrane is absent in case of *depidopterans* and *hemipterans*.



3. Hindgut or Proctodaeum: It extends from the posterior end of midgut, to the anus and is also an invagination of the body wall. The hindgut consists of the same layers as the foregut except that the circular muscles of its are developed both inside and outside the layer of longitudinal muscles. The hindgut is externally marked by the insertion of the Malpighian tubes and internally by the pyloric valve. It may be divided into three distinct regions:

- (i) Ileum or small intestine
- (ii) Colon or large intestine.
- (iii) Rectum

Ileum - It is a small tube which has many folds in its inner wall.

Colon- It is situated on the 5th and 6th segments of the abdomen and is a slender tube which can not be easily distinguished from the ileum. In some insects it is just like 'S' in structure.

Rectum - Both the ends of the rectum are comparatively slender while the middle portion is thick and large which consists of six rectal papillae internally and six ridges of longitudinal muscles externally. The rectum opens exteriorly through the anus which is situated at caudal end of the abdomen.

Salivary Gland

The labial glands which are associated with the gathal appendages are the salivary glands. A pair of salivary glands is found in the grasshopper which generally lie in the thorax and are convoluted tubes often branched and racemose, both the ducts of salivary glands unite together beneath the oesophagus to form a common salivary duct which opens into the salivarium.

Physiology of digestion

The grasshopper eats the leaves and soft parts of the plants which are held by the maxillae and they bring the food near to mandibles where it is broken into small particles. These small food particles are sent to the buccal cavity with the help of labrum and labium. After entering the buccal cavity, it is subjected to the action of saliva which contains the amylase enzyme. It acts on the carbohydrates present in the food and changes them into simple sugar i.e. Glucose which is absorbed in the crop. Saliva is also helpful in moistening the food. This food passes onward to the crop where the secretions of the midgut and the hepatic caecae mix with it. These secretions are weakly acidic or alkaline and contain maltase, invertase, lactase, protease, lipase, peptidase, erypsin and trypsin enzymes which act on the food. Due to the action of these enzymes the starch is converted to sugars, protein into amino acids and fat into fatty acids. After this the food comes to gizzard where it is again masticated and then it passes through the cardiac valve into mesenteron where further digestion of the food takes place. The digested food is absorbed by the spongy and thick walls of mesenteron. The undigested food passes to the hindgut (proctodaeum) through pyloric valve where the absorption of water takes place. Thereafter waste and undigested food is expelled through the anus in the form of excreta. The absorbed food is utilized for the following purposes

- (i) In the form of energy required for different life activities
- (ii) Some part is consumed in the formation of muscles etc.
- (iii) The rest is stored in the fat bodies which is used in emergency.