

Digestion System of Insects

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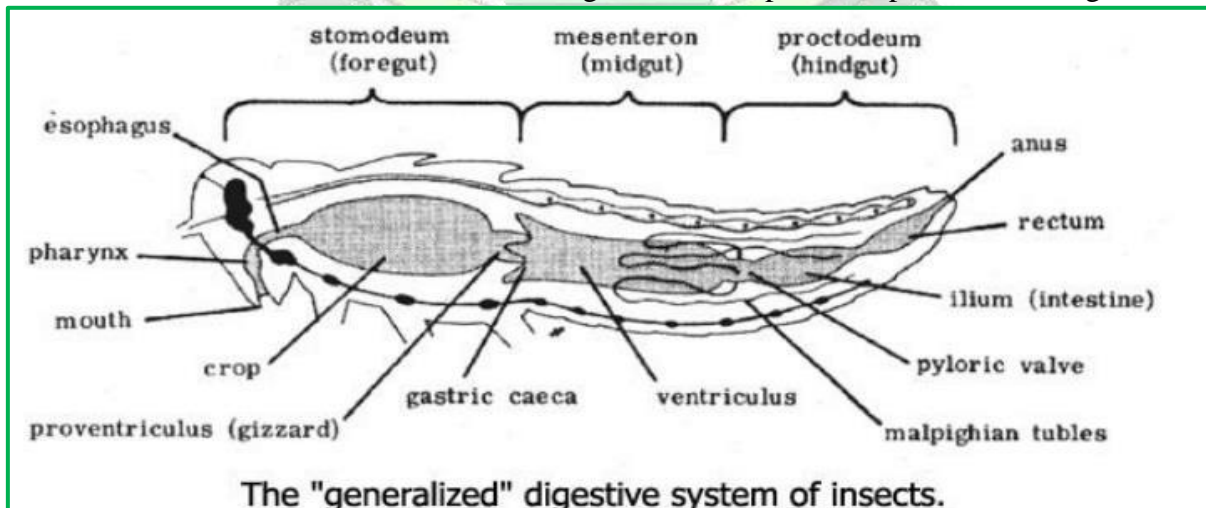
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An insect utilizes its digestive system to extract nutrients and other substances from the food it consumes. The majority of this food is consumed in the form of macromolecules and other intricate compounds (such as proteins, polysaccharides, fats, nucleic acids, and so on) which need to be broken down by catabolic reactions into smaller particles (*i.e.*, amino acids, simple sugars, *etc.*) before being utilized by cells of the body for energy, growth, or reproduction. This break-down process is known as digestion.

Insects may be phytophagous, entomophagous, wood borers, wool feeders saprophytic, mainly eating the solid food material which may be a plant part (or) tissue (or) wood, *etc.* Based on the food product ingested, there are structural modifications in the gastrointestinal system of insects. Insect feeding the solid food product having the biting and chewing kind of mouthparts and well-established gizzard whereas sap-feeding insects have sucking type mouthparts and have a filter chamber in the alimentary canal.

The alimentary canal of insects is a long, muscular, and tubular structure extending from mouth to anus. It is separated into three areas *viz.*, Foregut, Midgut, and Hindgut.

Foregut (Stomodaeum) – The foregut is ectodermal in origin. Anterior invagination of ectoderm form foregut (Stomodaeum). Internal cuticular lining exists. Terminal mouth parts lead into a preoral cavity. A preoral cavity in between the epipharynx and hypopharynx is called a Cibarium. Preoral cavity in between the hypopharynx and the salivary duct is Salivarium. Behind the mouth, a well-musculated organ called Pharynx exists which presses the food into the esophagus. Pharynx functions as a suction pump in sap feeders. The esophagus is a narrow tube that performs food into the crop. The crop is the dilated distal part of the esophagus functioning as a food tank. In bees' crop is called as honey stomach where nectar conversion occurs. Proventriculus or gizzard is the posterior part of the foregut and is



musculated. It is discovered in solid feeders and missing in fluid feeders or sap feeders. The internal cuticle of the gizzard is variously modified as follows

1. Teeth like in cockroach to grind and strain food.
2. Plate like in honey bee to separate pollen grains from nectar.
3. Spinal column like in flea to break the blood corpuscles.

Food circulation from foregut to midgut is managed through the Heart valve or esophageal valve.

Mid gut (Mesenteron or Stomach)- This area is likewise termed as stomach or midgut and its shape and capacity vary exceptionally. In many cases it is saclike, in others it is coiled and tubular like an intestinal tract or it may be divided into two or more regions. Internally it is lined by a line of enteric epithelium the outer ends of whose cells rest upon a base membrane. This is followed by an inner layer of circular muscles and an external layer or longitudinal muscles. The outermost coat of the stomach is a thin peritoneal membrane.

In numerous insects, the surface area of the stomach is increased by the development of sac-like diverticula the enteric or gastric caeca. These organs are normally positioned at the esophageal end of the stomach and are very variable in number. It is the middle one 3rd part of the alimentary canal which extends from hepatic caecae or cardiac valve to Malpighian tubes or pyloric valve.

The anterior a lot of part of the midgut surrounds the stomodeal valve is called cardia. From the front end of the cardia, 8 little and tubular finger-like blind processes project freely into the haemocoel. The internal lining of the wall of the midgut is an endodermal epithelium of columnar cells, raised into numerous little, villi like folds. The epithelium is internally covered not by cuticle, however by a thin, transparent peritrophic membrane formed of chitin and proteins. The long, slender, and yellow-colored blind tubules called Malpighian tubules, complimentary into the haemocoel from the hind end of the midgut, although associated with the digestion system, these tubules are actually concerned about excretion.

Hind gut (Proctodarium) - The hindgut is ectodermal in origin and produced by the posterior invagination of the ectoderm. The internal cuticular lining is present, which is permeable to salts, ions, amino acids, and water. The main functions of the hindgut are the absorption of water, salt, and other useful compounds from the faeces and urine.

The hindgut is distinguished into 3 regions viz., ileum, colon, and anus. In the larva of scarabids and termites, the ileum is pouch-like for housing symbionts and acts as a fermentation chamber. The rectum consists of rectal pads assisting in the dehydration of faeces and it opens out through the rectum.

Digestion glands

(a) Salivary glands

- A pair of large and whitish salivary glands is found one on each side, wrapped around the oesophagus and anterior narrower part of crop in the thorax.
- Each gland includes a flattened glandular part and a long, pyriform sac like reservoir of receptacle.
- The glandular part is biportite and divided into several small lobules also called as acini, in grape-like clusters.
- Fine ductules, arising from various, lobules, join together to form a single glandular duct.
- The reservoir is thin-walled and semi-transparent. A separate reservoir duct arises from it.
- The glandular ducts of both glands unite in front to form a common glandular duct. Similarly, the reservoir ducts of both glands unite in front to form a common reservoir duct.

- Then, the common glandular and reservoir ducts also unite to form a common efferent salivary duct.
- The latter traverses through the neck and head and eventually opens upon hypopharynx in the pre-oral space just in front of mouths.
- The wall of all major ducts of salivary glands is reinforced by spring-like cuticular rings at its inner surface.

In Cockroach a pair of labial glands function as a salivary gland where the salivary ducts open into the salivarium. In caterpillars' mandibular glands are customized to produce saliva, where the salivary glands are customized for silk production.

Functions of saliva

- (i) To moisten and to liquify food.
- (ii) To lubricate mouthparts.
- (iii) To add flavor to gustatory receptors.

(b) Hepatic caecae and midgut epithelial cells

It produces the majority of the digestive Juices. Two types of cells are associated with enzyme secretion.

- (i) Holocrine: Epithelial cells break down in the process of enzyme secretion.
- (ii) Merocrine: Enzyme secretion happens without cell break down.

Digestation in microbes

In the insect body, few cells are housing symbiotic microorganisms called mycetocyte. These mycetocytes aggregate to form an organ called mycetome.

- (i) Flagellate protozoa – It produces cellulase for cellulose food digestion in termites and wood cockroaches.
- (ii) Bacteria – It helps in wax digestion in the wax moth.