CHAPTER - FOUR

DISCUSSION

Discussion on histology, and histochemistry of mucosubstances in various organs in the alimentary canal of *P. posthuma* and *H. granulosa*.

The annelids form one of the largest group of triploblastic and coelomate invertebrate life forms and include the familier earth worms, leeches and polychaete worms. Before the turn of this century the annelids were studied for their morphology, taxonomy, systematic position and evolution. Since then however, a great attension was paid to their ecological studies and their bioeconomics. At present voluminous data have accumulated on their evolution, taxonomy, morphology, ecology, bioeconomics, anatomy etc. The studies on the anatomy of the organs in a given system, were restricted to the external appearance of organs and variations in them at a comparative level. During last few decades research on physiology of annelids was oriented to study detailed analysis of fundamental physiological mechanism, to gain an understanding of the way in which animal meets the physiological requirement of living in a particular environment and to set the physiological mechanism of different animals in the evolutionary context. The knowledge of annelid physiology and biochemistry was to overwhelming extent derived from only a handful of species : a few nereids and the earthworm. A critical analysis of the existing literature shows that the most of the annelids have been studied for anatomy, comparative anatomy & physiological mechanism of the life processes performed by different organs. In some cases nervous and hormonal control on physiological mechanisms have been studied. Different organs and systems in the annelids have been studied from the point of view of the structure, secretions and physiological and biochemical mechanisms and comparatively less attention was paid to the histology and histochemistry of these organs. The organs in the alimentary canal of annelids were studied for their structure, developmental regions, secretions, physiology of digestion and absorption and very little is know about their histology and histochemical localization of different metabolites. At present very little information is available on the histology of the alimentary canal in annelids. Histology of the alimentary canal in earthworm, P. posthuma and Indian cattle leech, H. granulosa has been reported, practically no work has been carried out on histochemical localization of mucosubstances in the alimentary canal of these two annelids.

In the present investigation the earthworm, P. posthuma and the Indian cattle leech, H. granulosa were used as they were available in sufficient number in this locality. It was decided to investigate the histology of different organs in the alimentary canal and to study histochemical characterisation and distribution of mucosubstances in various organs of the alimentary canal in these two annelids. In light of the observations (Chapter III) made it is proposed to discuss some of the points in brief and to compare the present observations with other annelids.

I. THE ALIMENTARY CANAL IN EARTHWORM AND LEECH :

The alimentary canal of annelids like that of other animals is formed from three parts : a middle region derived from the endoderm, joined by anterior stomodeal and posterior proctodeal invaginations of the ectoderm.

A. The Alimentary Canal in P. posthuma :

The alimentary canal in *P. posthuma* was a straight tube running along the entire length of the body, open at either ends by mouth and anus. It was functionally regionated into different regions such as buccal chamber, pharynx, oesophagus, gizzard, stomach and intestine. The mouth was located ventral to the prostomium and lead in to the buccal chamber that extended upto the middle of the third body segment. The pharynx that followed the buccal chamber, was pear-shaped, muscular organ and extended upto fourth segment. The pharynx continued behind as oesophagus that ran upto the seventh segment as a thin walled short narrow tube and in eighth segment it was modified into oval and thick walled gizzard. The gizzard was followed by a short narrow tube the stomach that extended from ninth to fourteenth segment. The intestine was a long, wide, thinwalled tube running from fourteenth to the last body segment. The intestine was divided into

Pre-typhlosolar region (From fifteenth to twenty sixth segments), typhlosolar region (from twenty sixth segment upto twenty three to twenty six segments in front of anus) and post-typhlosolar region or rectum (in the last twenty three segments). In the twenty sixth segment a pair of forwardly directed intestinal caecae were present in the pre-typhlosolar region. The present investigation confirms the morphological divisions of the alimentary canal earlier reported by Bahl (1926).

The oligochaetes are considered omnivorous and live primarily on detritus (Van Gansen, 1962; Jeuniaux, 1969; Edwards and Lofty, 1972). The prostomium is small and may act as downward scoop bringing food into pre-oral canal in lumbricus (Arthur, 1965) and in Pheretima(Bahl, 1926). There are considerable variations in the anatomical feature of the alimentary canal of larger, terrestrial worms. (Avel, 1959; Cook, 1972). In general, mouth is located beneath the prostomium, opens in to a short buccal cavity, which is lined with the cuticle continuous with that of the body wall (Van - Gansen, 1962; Palka and Spaul, 1970). The pharynx and buccal cavity have diverticula (Stephenson, 1930). The oesophagus opens from the pharynx as a narrow tube and may be modified into a dilated thinwalled crop and thick walled muscular gizzard (Stephenson, 1930). The gizzard is present in all families of megadriles and may be multiple. The stomach is thin wall short tube may or may not be a dilation (Stephenson, 1930). The intestine is a simple cylindrical tube with a small typhlosole along the major part of the intestine (Palka and Spaul, 1970; Cook, 1972). Four well defined regions have been described for the intestine of E. foetida (Van - Gansen, 1962) and L. terrestris (Arthur, 1963). These regions are the contractile anterior region, middle intestinal region, the region with typhlosole and the posterior intestine. The intestine in P. posthuma is distinguished into three regions only. (Bahl, 1926). These regions are pretyphlosolar intestine, typhlosolar region and the post-typhlosolar (rectum) region of the intestine.

B. Alimentary Canal in H. granulosa :

The alimentary canal of leech was a complete tube extending from mouth to anus. It was regionated into preoral chamber, buccal cavity, pharynx, oesophagus, crop, stomach, intestine and rectum. The pre-oral chamber was located ventral to the oral sucker and lead to a very short chamber, the buccal cavity. The mucous membrane of the buccal cavity contained three cresentic jaws bearing monostichodont teeth on its edge. The buccal cavity opened in pharynx through a narrow aperature. The wall of the pharynx was highly muscular and traversed by the ductules of the salivary glands that surround the pharynx. The pharynx extended from fifth to eighth segments. The crop was the largest part of the alimentary canal that occupied about two-third of the visceral space. The crop extended from ninth segment to the eighteenth segment. The crop was divided by narrow constrictions into a series of ten to eleven chambers. From each chamber arose a pair of lateral backwardly directed diverticula or caecae. The caecae of the last chamber ran on either sides of the stomach and intestine and extended upto the rectum in the twenty sixth segment. The stomach was a small, rounded chamber that occupied nineteenth segment. The intestine continued as a narrow tube from segment twentith to twentysecond segments. The thin walled rectum, which follwed the intestine, opened outside by anus. The present investigation on H. granulosa confirms the different divisions of the alimentary canal reported earlier by Bhatia (1942).

The sanguivorous Gathobdellid leeches show a wide variety of anatomical structures in harmony with the various procedures involved in the uptake of food (Harant and Grasse, 1959). In G. complanta (Damas, 1969) the buccal cavity is transformed into an eversible sheath, which possesses powerful longitudinal muscles. In H. medicinalis the wide mouth leads directly to the pharynx which was provided with three jaws (Damas, 1972). The unicellular salivary glands that surrounded the pharynx emitted their secretion through ductules opening around the teeth (Dev and Mishra, 1971). The crop is the longest part of alimentary canal and often possesses numerous paris of blind diverticula, generally the last pair is longer and can reach the posterior end of the body (Harter, 1968). In numerous leeches the intestine is a straight tube and narrower than crop that continues as rectum and open dorsally as anus just before the posterior sucker. The crop in H. granulosa consisted of ten to eleven chambers with lateral diverticula (Bhatia, 1941).

II. HISTOLOGY OF THE ALIMENTARY CANAL :

Histological structure of the alimentary canal in earthworm and leech exhibited simple structure and lacked complex glandular structures.

A. Histology of the gut wall in Earthworm :

Histologically, the wall of the alimentary canal in earthworm, P. posthuma consisted of four layers in succession. The outermost layer was the peritoneum, consisting of tall and narrow cells. Some of these peritoneal cells on the intestine and sometimes on the stomach contained yellow refractile granules. These cells were the chloragogen cells peculier in the earthworm intestine. The muscle layer consisted of outer layer of longitudinal muscle fibres and inner layer of circular muscle fibres. The longitudinal muscle layer was considerable thin. The muscles in the buccal cavity formed a mass of muscular strands that filled up the greater part of the coelomic cavity of this region. The muscles were well developed in pharynx and oesophagus but ill-defined in the intestine. The entire thickness of the wall of the gizzard was made up of circular muscle fibre only and there being no longitudinal muscles. The muscle, both longitudinal and circular, were non-striated and involuntary. The innermost layer of the gut wall; facing the lumen has lining of the epithelial cells. The inner epithelial layer was thrown into folds in oesophagus, stomach and intestine. The inner epithelial layer consisted of a single row of columnar cells which became ciliated on the roof of pharynx, glandular in stomach and glandular and absorptive in the intestine. The epithelium in buccal chamber was non-ciliated and contained few mucous gland cells anteriorly, particularly in the floor portion of the prostomomium. The pharyngeal epithelium consisted of columnar cells which were ciliated on the roof of the pharynx but not on the floor. The pharyngeal gland cells were large in size and possessed varied shapes occured in the roof musculature of the pharyngeal lumen. The epithelial layer was transversely folded and consisted of tall columnar cells, where as epithelial cells were cuboidal in the gizzard. The epithelial cells in the stomach and intestine were ciliated and glandular in nature. The internal epithelium was lined by thin lining of cuticle in the buccal cavity and thick in the gizzard as a thick lining. Similar histological observation were reported by Bahl (1926, 1950) on the gut wall of P. posthuma. The present investigation confirms these observations reported by Bahl (1950).

Most of the Oligochaetes shows similar histological structures in the gut wall. The buccal cavity is lined with cuticle which is continuous with that of the body wall. The buccal cavity has an associated musculature which permits protrusion of the ectoderm (Van - Gansen, 1957; Arthur, 1965; Plaka and Spaul, 1970). In lumbricus, the pharyngeal epithelium has cuticle, and ciliated columnar cells in the dorsal region (Stephenson, 1930). Protractor and retractor muscles, attached to the pharynx from the dorsal body wall have been observed in some lumbricids (Cook, 1972). Associated with the dorsal and lateral wall of the pharynx are present the groups of the glandular cells (Avel, 1959). The ultrastructure of the paired pharyngeal glands in E. albidus has been described by Reger (1967). Elongated cytoplasmic processes extend from the individual gland cell to the pharyngeal lumen and serve to transport secretory products. A similar morphology has been described for cells in pharyngeal glands, of E. foetida (Chapron, 1970). Histological studies by Palka and Spaul (1970) in L. lineatus, showed that the oesophagus is lined with cuboid non ciliated epithelial cells. In P. hawayana, the gizzard is preceded by a primary oesophagus of simple columnar epithelium and followed by a stomach with a striated border of columnar epithelium. In E. foetida the oesophagus has lining of cuticulated epithelium containing few gland cells (Burke, 1974). The glandular swellings on the stomach of lumbricids, are the calcareons glands. (Stephenson and Prashad, 1919), and secrete calcareous fluid. In Pheretima, there are no calcareous glands in the stomach but the transverse folds of the internal epithelium may be regarded as the simplest condition of the calciferous glands (Bahl, 1950).

The intestine of the microdriles contains an epithelium of ciliated columnar cells, a thin muscular layer and a layer of chloragogen cells in the peritoneum (Cook, 1972). Large glandular cells are scattered among the prominent non glandular ciliated columnar cells, especially in mid-portion of the intestine (Palka and Spaul, 1970). The typhlosole in E. foetida containes ciliated and glandular cells. (Van - Gansen, 1962). In P. hawayana the typhlosolar intestine and associated caecae have epithelium of ciliated cells alternating with club shaped glandular cells which are abundent in the typhlosole. In P. posthuma the chloragogen cells occured in less number in the peritoneum of the stomach whereas in the intestine distributed uniformly and in abundance. The glandular cells occured both in the stomach and intestine. The typhlosolar region intestine contained the glandular cells in abudance. The stomach, pretyphlosolar region of the intestine and the post-typhlosolar intestine contained comparatively less number of these gland cells. The mucous gland cells also occured in the inner epithelium of the buccal cavity, pharynx and oesophagus. The mucous gland cells exhibited vacuolar appearance to the cytoplasm and primarily secreted the mucous.

B. Histology of the gut wall in Leech :

The gut wall in H. granulosa, consisted, histologically, of a layer of columnar epithelium separated by a basement membrane from an outer layer of connective tissue, and muscle fibres in the connective tissue. The columnar epithelium formed the inner most layer of the gut wall and contained rodlets or brushborder at their free apical ends. The columnar epithelium was lined by cuticle in the fore and hind guts. The epithelium contained goblet cells in the crop. The tubular glands were reported in the epithelium of the pre-oral chamber. The connective tissue layer contained haemocoelomic capillaries and muscle fibres. The pre-oral chamber connective tissue contained circular as well as longitudinal muscle fibres while in pharynx it contained circular, longitudinal and radial muscle fibres.

In the Gnathobdellae the pharynx is provided with a powerful muscle coat consisting of circular, longitudinal and radial fibres. In blood sucking leech, H. medicinalis, the radial muscles are particularly developed (Hammersen, 1963). The structure of the crop in Hirudo has been examined in normally feeding and fasted animals under optical (Diwany, 1925) and electron microscope (Hammersen and Pokahr, 1972a). The epithelium is lined with striated border composed of numerous microvilli and its cytoplasm contains many apical mitochondira and abundant fatty inclusion that represents a reserve of energy. Under the epithelium of the crop and intestine the wall consists of a weak muscular system and connective tissue (Hammersen and Staudte, 1967). The cells in the rectum are short and narrow in H. granulosa. On the cuticular lining, is a layer of symbiotic bacteria, which are mistaken for cilia (Bhatia, 1977). The histological appearance of the gut wall of the H. granulosa, was similar to that described by Bhatia (1941).

III. LOCALIZATION OF MUCOSUBSTANCES IN THE ALIMENTARY TRACT OF EARTHWORM *P. posthuma* :

The wall of the alimentary canal in *P. Posthuma*, is distinguished into four histological layers which occured in all the organs in digestive tract. These layers are outer peritonium followed by a layer of longitudinal and a layer of circular muscles and inner layer of epithelium. These four layers showed slight variations in some of the organs in the alimentary canal which are described in the histological observations and the two muscle layers are collectively referred muscular layers. Histochemical observations revealed occurence of different cell types in the inner epithelium and outer peritoneum while muscle layer exhibited no variations in the histochemical results.

The peritoneal epithelial in the different organs of the alimentary canal showed presence of only diastase resistant PAS reactive neutral mucosubstances but absence of glycogen and other mucosubstances in them. This conclusion was based on the histochemical reactivities of this layer. The chloragogen cells which occured in the peritoneal epithelium of the stomach and intestine contained glycogen in them. Earlier Bahl (1950) reported that the chloragogen cells act as a storehouse for reserve nutriment; in the absence of liver. The present investigation shows presence of glycogen as reserve nutriments in the chloragogen cells.

The musculature of the gut wall consisted of outer longitudinal and inner circular muscles. The longitudinal muscles were absent in gizzard while intestine has a thin muscular layer. The muscles in various organs from mouth to anus, exhibited similar tinctorial histcchemical affinities. The histochemical reactivities, indicate presence of glycogen in the muscles. The muscle cells exhibited PAS staining which could be blocked by phenylhydrazine pretreatment and abolished by diastage digestion. The muscles remained unstained with alcianophilic dyes and showed only PAS staining in sequential staining techniques. Thus, the present histochemical results revealed presence of glycogen in the muscular layer of different organs in the alimentary tract of the earthworm. The importance of glycogen as an energy source for muscle contraction has been known for many years (Parnas and Wagner, 1914; Meier and Meyerhof, 1924) Numerous reports are found in literature concerning the concentration of muscle glycogen as influenced by various nutritional, hormonal and other physiological factors (Stetten and stetten, 1960).

The histochemical results revealed the presence of neutral mucosubstances in the inner epithelial lining cells in the entire alimentary canal. Further, the staining reactivities indicated absence of glycogen in these cells. Within the epithelium in different organs are scattered mucous gland cells, pharyngeal gland cells, gland cells etc. There histochemical reactivities indicated presence of different mucopolysaccharides in them.

The mucous gland cells in the buccal chamber were numerous, tall and secreted slime. Similar mucous gland cells were reported in pharyngeal and oesophageal epithelium but they occured in less number. The histochemical reactivities of the mucous gland cells revealed presence of neutral mucosubstances (predominant) and sulfomucins in them.

The pharyngeal glands in the pharynx formed a rich glandular structure of varying shape. Various histochemical reactivities indicated presence of neutral mucosubstances (in traces), sialomucins (in traces) and sulfomucins (predominant) in these cells.

The gland cells in the stomach and intestine exhibited intersting distribution of mucosubstances. The gland cells in stomach contain sulfomucins in traces and neutral mucosubstances in large quantities. The intestinal gland cells showed similar histological appearance but histochemical studies have distinguished them in to two type, G_1 and G_2 gland cells. The G_1 gland cells exhibited moderate alcianophilia with AB pH 1.0 staining whereas the G_2 gland cells remained unstained with AB at pH 1.0. The histochemical staining reactivities of G_1 gland cells showed presence of neutral mucosubstances, sialomucins and sulfomucins in them. The G_2 gland cells contained neutral mucosubstances and sialomucins in them.

The cuticle that lined the inner epithelium of the buccal cavity and the gizzard remained unstained with all the histochemical reactivities Van - Gansen (1959) reported that the cuticle of the earthworm gizzard is simply collagenous and in E. foetida the epithelium of the gizzard produces a thick elastin cuticle (Van Gansen, 1962).

The pharyngeal glands are mainly mucous producers, the mucous lubricating the food (Van - Gansen, 1957) Earlier Keilin (1920) reported that the pharyngeal gland cells are large in size and their function is to produce mucous and a proteolytic enzyme. The calciferous glands that secrete calcareous fluid are reported in the stomach of lumbricus (Stephenson and Prashad, 1919). In Pheretima, there are no calciferous glands in the stomach but transverse folds of the internal epithelium may be regarded as simplest condition of the calciferous glands. In earthworms ingested soil is led from the oesophagus through a crop and gizzard to the intestine in which both secretory and absorptive cells are found (Van - Gansen, 1959).

With regards to the distribution of the mucosubstances the present investigation revealed the presence of neutral mucosubstances in the peritoneal epithelial cells and inner epithelial cell lining. The muscularsis and the chloragogen cells in the peritoneal layer of stomach and intestine contain only glycogen. The mucous gland cells in the inner epithelium contain neutral mucosubstances and sulfomucins. The pharyngeal glands are reported to contain neutral mucosubstances, sialomucins and sulfomucins in them. The G_1 gland cells in the intestine contained a mixture of neutral mucosubstances, sialomucins and sulfomucins, whereas G_2 gland cells contain neutral mucosubstances and sialomucins. The sulfomucins are known as biological lubricants (Lison, 1960; Goudsmit, 1972).

IV. LOCALIZATION OF MUCOSUBSTANCES IN THE ALIMENTARY TRACT OF LEECH *H. granulosa* :

Histologically, the wall of the alimentary canal consists of a lyaer of columnar epithelium as the innermost layer facing the lumen of the gut. The epithelial cells are surrounded by an outer layer of connective tissue. The connective tissue layer contains haemocoelomic capillaries and circular muscle fibres. The pre - oral chamber contains circular as well as longitudinal muscle fibres, while in pharynx circular, longitudinal and radial muscle fibres are present. The columnar epithelium is lined by cuticle in the fore and hind guts. The epithelium in the crop contained scattered goblet cells. Histochemical observations revealed occurence of tubular gland cells in the pre-oral chamber and mucous gland cells in the buccal cavity and goblet cells in the crop. The pharynx is surrounded by unicellular salivary glands.

The connective tissue formed a layer around the inner epithelial cell lining and exhibited identical histochemical reactivities in pre-oral chamber, buccal cavity, pharynx, crop, stomach, intestine and rectum. The tinctoreal staining reactivities of the connective tissue indicated presence of neutral mucosubstances and hyaluronic acid. The presence of hyaluronic acid in the connective tissue is now well established (Meyer, 1947; Wislocki et. al., 1947; Jackson, 1964; Mathews, 1967).

The muscles in the gut wall of leech are not forming a uniform layer as in other annelids. The muscle occured within the connective tissue. The pharyngeal connective tissue contained circular, longitudinal and radial muscle whereas the pre-oral chamber contained both, circular and longitudinal muscles, remaining organs contained circular muscles scattered in the connective tissue. The muscles in the gut wall of leech showed identical histochemical staining reactivities for the mucosubstances. The staining reactivity of the muscles indicated presence of only glycogen in them. From the staining intensities, it is evident that the glycogen contents are more in muscles of pharynx, crop stomach and intestine. The glycogen is reported as an important energy source for muscle contraction (Parnas and Wagner, 1914; Meier and Meyerhof, 1924) and its concentration in muscle cell is influenced by nutritional, hormonal and other physiological factors. (Stetten and stetten, 1960).

The epithelial cells in the alimentary canal of leech showed identical histochemical staining reactions in all regions, indicating presence of neutral mucosubstances but absence of glycogen and acidic mucosubstances in them.

In G. complanata most of the intestinal cells are rich in alkaline phosphtase, fats and glycogen (Damas, 1962). In H. medicinalis the cells also contain fat and glycogen (Diwany, 1925). In Hirudo, electron microscopy showed that the epithelium is lined with a striated border composed of numerous microvilli and its cytoplasm contains many apical mitochondria and abundent fatty inclusions (Hammersen and Pokahr, 1972a). During prolonged fasting the fats are reabsorbed.

The epithelium in pre-oral chamber, buccal cavity and crop contained specialized cells such as tubular gland cells, mucous gland cells and the goblet cells respectively.

The tubular gland-cells in the pre-oral chamber and the mucous gland cells in the buccal cavity showed identical histochemical staining reactivities which indicated presence of neutral mucosubstances (predominant) and sulfomucins (traces) in these cells.

The goblet cells in the crop contained neutral mucosubstances (traces), sialomucins (traces) and sulfomucins (predominant).

The salivary glands in leech, were large masses of pyriform unicellular glands covering and surrounding the wall of the pharynx. Histochemical reactivities of these cells indicated presence of neutral mucosubstances (traces), sulfomucins (predominant) and sialomucins (traces). The holocrine, unicellular salivary gland were reported in G. complanata by Damas (1969) and these cells contained alkaline Phosphatase. Pokharia (1984) demonstrated acid phosphatase in the salivary glands of the land leech, Haemadipsa zeylanica and that there was no enzyme activity in ductules. With histochemical techniques Damas (1974) distinguished mucous glands which secreted acid mucopolysaccharides from serous gland which synthesized histamine, hyaluronidase and proteases. In H. granulosa some salivary glands show adenosine triphosphate activity (Dev and Mishra, 1971). The anticoagulent hirudin is characterised as antithrombokinase (Lenggenhager, 1936) and has been isolated in α and β hirudin (Jutisz, 1963). Different chemical substances have been biochemically identified from homogenates of the head, and attributed to the salivary glands. Hyaluronidase as pointed out by Claude (1937) and Hann (1945), has been characterised as β-glucuronidase (Linker et. al., 1957, 1960). The saliva of H. medicinalis is reported to contain hirudin, eglin, hyaluronidase, collagenase and apyrase (Rigbi et. al. 1987). Leech collagenase and apyrase were reported for the first type and collagenase was identified as belonging to the mammalian type. Hyaluronidase preparation of Sanguisuga granulosa have been compared to the enzyme from H. medicinalis (Budds et. al. 1987). Both enzymes have an endo β-glucuronidase mode of action and are specific for hyaluronic acid.

With regards to the distribution of mucosubstances the present investigation revealse the presence of neutral mucosubstances and hyaluronic acid in the connective tissue. The muscles contained only glycogen in them. The tubular and mucous gland cells in pre-oral chamber and buccal cavity respectively contained neutral mucosubstances and sulfomucins. The goblet cells in the crop and the salivary glands showed presence of neutral mucosubstances, sulfomucins and sialomucins.

V. PROBABLE FUNCTIONAL SIGNIFICANCE :

Although the occurence of glandular structures have been reported in the alimentary tract of the annelids, their functions have been discussed in some.

The earthworms are omnivorous and obtain nourishment from organic material present in the soil. Earthworms ingest large quantities of earthy matter. The swallowed matter passes through the buccal chamber into pharynx where it is mixed with the secretions of the pharyngeal glands. The secretions in pharyngeal glands contain mucin and proteiolytic ferment (Keilin, 1920); the mucus lubricates the food and helps the formation of the food bolus (Bahl, 1950). Van-Gansen (1957) also reported that the pharyngeal glands of earthworm are mainly mucus produceds; the mucus lubricating the food. It is now a established fact that the sulfomucins are known to function as biological lubricants. (Lison, 1960; Goldsmit, 1972). The sulfomucins have been shown to occur in the mucous gland cells in the buccal chamber pharyngeal gland cells and G_2 gland cells in the intestine. Secretions of these glandular elements, therefore lubricate the food and protect the wall of the gut from mechanical injuries and permit easy passage of food from one segment of the gut to another for the digestive action. Further, it makes the food moist, suitable of enzyme actions and dissolution of simple organic substances that are present in the earthy matter swallowed by the earthworms. Monceaux (1935) reported that mucins absorb all acidity beyond the physiological pH. Kent (1971) Opined that secreted mucus carries out an obivious lubricant function and may possibly play a role in preventing dehydration.

The calciferous glands secreting a calcareous fluid have been reported by stephenson and Prashad (1919) in octochaetoides, Eutyphoes and lubricus. In pheretima there are no calcareous glands but transverse folds of the internal epithelium of the stomach may be regarded as the simplest condition of calciferous glands in this earthworm. (Bahl, 1926). These cells excrete excess of the calcium salts in the form of calcite crystals (Robertson, 1936).

The chloragogen cells function as storehouse for reserve nutriments; in the absence of a liver the chloragogen cells are believed to have a hepatopancreatic function (Bahl, 1950). In the present investigation glycogen is reported to occur in the chloragogen cells.

The Indian cattle leech, H. granulosa is a sanguivorous ectoparasitic annelid and ingest large quantities of blood from its host. The digestion is a very slow process and takes about six months. The salivary gland cells in leeches, secrete hirudin that prevent clotting of blood and permit easy feeding. Alkaline phosphatase (Damas, 1969) and acid phosphatase (Pokharia) were reported to occur in these gland cells. Damas (1974) reported presence of acid mucopoly saccharides in serous salivary glands which synthesized histamine, hyaluronidase and proteiases. Neutral mucosubstances, sulfomucins and sialomucins are reported in the salivary glands in H. granulosa.

Stirling and Brito (1882) and Putter (1908) claimed that the blood does not undergo any change in the crop. Bhatia (1941) observed haemolysed blood in the crop. It is probable that the secretions of goblet cells take part in this process.