

Chapter 13

Digestive System

(Oral Cavity and the Alimentary Canal)

13.1. Basic Concepts

The digestive system is involved with the intake, mechanical and chemical breakdown, and absorption of food. It also eliminates the undigestible residue through defecation. The end products of digestion are carried through the blood stream and lymphatics to all of the tissues of the body. Digestion involves the digestive tract and accessory organs. The accessory organs are located outside of the alimentary canal and secrete their products into the tract via ducts. Their products are a variety of enzymes for the chemical breakdown of food.

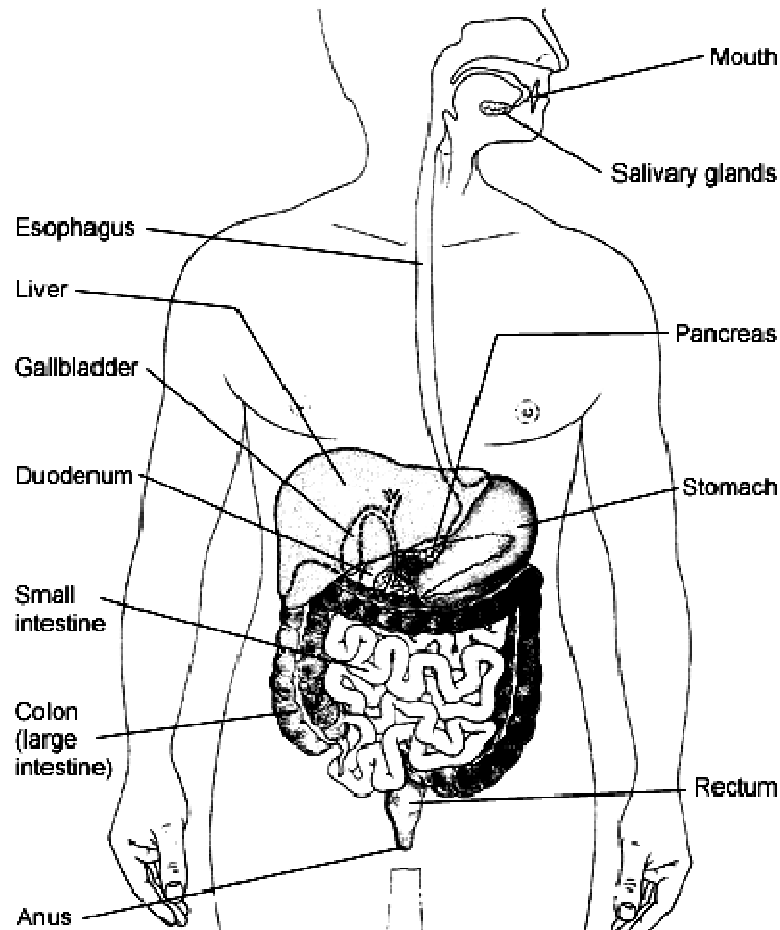


Fig.13.1. Human Digestive System

The accessory glands include the salivary glands, liver, gall bladder, and pancreas. The digestive tract is also known as the "G.I. tract" or "alimentary canal". The entrance to the G. I tract is the oral cavity where food is masticated, mixed with saliva, and formed into a

bolus. The bolus is passed to the pharynx which will convey it to the esophagus, the start of the digestive tube proper. This muscular tube will conduct the bolus to the stomach where muscular contractions mix it with gastric enzymes and HCl to form the semifluid chyme. The chyme is delivered to the small intestine where the bulk of digestion and the absorption of nutrients occurs. The small intestine is divided into three segments: duodenum, jejunum, and ileum.

To assist in the chemical breakdown of food there are a variety of chemical agents produced by the pancreas, liver, and the small intestine itself. The residue is passed on to the large intestine. In the large intestine there is a slight degree of nutrient absorption but the main function is to prepare and eliminate the feces. The large intestine is divided into the: colon, cecum, rectum, and anal canal. The colon is the longest segment and is subdivided into the: ascending colon, transverse colon, descending colon, and sigmoid colon. The vermiform appendix is attached to the cecum.

13.2. The Oral Cavity

The oral cavity is also known as the buccal cavity, or mouth, and includes the: lips, cheeks, roof of the mouth (being composed of the hard and soft palates), tongue, gingivae, teeth and the salivary glands. The oral cavity proper extends from the vestibule (the space between the lip + cheeks and the gingivae + teeth) to the fauces (the opening into the oropharynx. Although histologically distinct from the digestive tube, the oral cavity is the entrance to the alimentary canal.

The lining of the oral cavity is a mucus membrane consisting of an oral mucosa resting on a submucosa. The other layers will depend on the location. Ex; deep to the submucosa on the soft palate is skeletal muscle. The oral mucosa consists of a stratified squamous epithelium resting on a relatively cellular lamina propria. The stratified squamous epithelium will range from nonkeratinized to parakeratinized depending on location and the degree of wear and tear that it has been exposed to. The lamina propria will be well vascularized and rich in lymphoid cells. The oral submucosa is a loose connective tissue layer. It is lacking in the region of the hard palate where the lamina propria fuses directly on to the periosteum of the palatine and maxillary bones. The submucosa will contain groups of intrinsic salivary glands called Buccal Glands whose ducts penetrate the mucosa. The secretions of these minor salivary glands can be serous, mucus, or mixed in nature.

13.3. The Tongue

The tongue consists of a core of skeletal muscle bundles covered by a mucus membrane. The anterior two thirds of the tongue is separated from the posterior third by the terminal sulcus. The paired muscle bundles of the tongue are separated by the median septum which divides the tongue into right and left portions. The dorsal surface of the anterior tongue will have numerous small protuberances of the mucus membrane called Papillae. There are four classes of papillae:

a) Filiform Papillae - slender projections that are 2 to 3 mm in length. They consist of a connective tissue core covered by stratified squamous epithelium (as is the case for all papillae). The surface epithelial cells are parakeratinized. This causes them to appear whitish. These cells are alive. The nucleus is present, although reduced. The cells are rich in keratin but there isn't enough to kill the cell.

b) Foliate Papillae - very rare, leaf shaped papillae found along the margin of the

tongue.

c) Fungiform Papillae - mushroom-shaped papillae. Their connective tissue core is well vascularized and their epithelium is nonkeratinized. So these papillae appear to be red. Fungiform papillae will often contain taste buds.

d) Circumvallate Papillae - the largest, most complex and least numerous type. There are between 10 to 12 circumvallate papillae along the terminal sulcus forming a "V". Each papillae is partially sunk into the mucosa and is surrounded by a circular trench. Their lateral surfaces are covered by taste buds. The ducts of serous glands called von Ebner's glands open into these trenches to provide a solvent for the detection of taste.

13.4. The Taste Buds

The taste buds are small pale ovoid bodies located within the darker staining mucosal epithelium. They will extend from the basement membrane to open on to the surface of the tongue by Taste Pores. Taste buds are distributed on both fungiform and circumvallate papillae, soft palate, glossopalatine arch, epiglottis, and posterior pharyngeal wall.

Histologically, there are two cell types present in the taste bud. They are arranged like segments of an orange: Taste Cells/Gustatory Receptor cells - these are neuroepithelial cells. They have elongate stereocilia that extend into the taste pore so as to detect gustatory stimuli. Gustation is a chemoreceptive sense and so the stimulus must be in solution for detection. Associated with these neuroepithelial cells are sensory neurons which will pick up the impulse and conduct it towards the brain.

Supporting Cells/Sustentacular Cells - columnar epithelial cells that surround, protect, and aid the taste cells. There are only four taste sensations: sweet, sour, bitter, and salty.

13.5. The Extrinsic Salivary Glands

In addition to the minor salivary glands the mouth also has three pairs of major salivary glands: the parotid, the submandibular, and the sublingual glands. These are compound glands consisting of several lobes that are further divided into lobules by connective tissue septa. The secretory portion will be either alveolar/acinar or tubuloalveolar/tubuloacinar. These extrinsic glands are located outside of the oral cavity and release their products into the mouth by means of ducts. The duct system is least developed in the sublinguals and most developed in the parotids. The secretion will be moved from the secretory portion to the duct system by contraction of myoepithelial cells.

a] The Basic Duct System

1] Intralobular Ducts - are the smallest branches and will receive the product directly from the secretory portion. They are microscopic and located within the lobules. There are two types of intralobular ducts, one leading into the other:

1} Intercalated Ducts - the first to receive the product. At the acinus or tubule they are lined by a simple squamous epithelium. Closer to the second type of intralobular duct they become progressively taller and are lined by a simple cuboidal epithelium.

2} Striated Ducts - receive the product from the intercalated ducts.

The striated ducts are lined by a simple columnar epithelium that demonstrates basal infoldings. These striations are due to infoldings of the basal cell membrane which yield energy for the ion pumps which will actively modify the passing products of the salivary glands.

2] Interlobular Ducts - arise from the union of intralobular ducts and run between the lobules. They are lined by a tall simple columnar epithelium and also contain connective tissue from the interlobular septa.

3] Lobar Ducts - arise from the union of several interlobular ducts. They are lined by epithelium ranging from high simple columnar to stratified cuboidal. One lobar duct will drain an entire lobe.

4] Major Excretory Duct - is formed by the fusion of the lobar ducts and opens onto the oral mucosa. It is lined by a stratified epithelium, the exact nature depending on the duct and the location.

b) The Three Extrinsic Salivary Glands

1) The Parotid Glands

The parotids are the largest salivary glands. They are located subdermally, superficial to the masseter muscle, immediately anterior to the pinna. In the adult, the parotid gland contains only serous acini which secrete a watery substance. The secretions include: water, salts, protein, the enzymes lysozyme (to destroy bacteria) and amylase (which will hydrolyze carbohydrates to yield disaccharides). Each parotid gland will have one major excretory duct, the parotid duct, which will be lined by stratified squamous epithelium. It opens into the cheek at about the level of the second upper premolar.

2) The Submandibular Glands

These glands are located near the posterior portion of the mandibular angle. These glands are compound tubuloacinar glands with primarily a mixed seromucus product. Their product is intermediary between the parotid and sublingual glands. Some of the secretory portions of the gland are mucus tubules, some are serous acini, but most are mixed being a mucus tubule capped by a serous demilune. They will have several major excretory ducts per glands, called the submandibular ducts, which will open onto the floor of the oral cavity. The ducts histology runs from stratified cuboidal at the fusion of the lobar ducts, to stratified columnar, and in some cases to stratified squamous at the opening.

3) Sublingual Glands

These glands are located in the floor of the mouth below the tongue. They are compound tubuloacinar glands. The secretion is mixed seromucus. In these glands the mucus tubules predominate. Most of the mucus tubules are independent but some will be capped by serous demilunes. Pure serous acini are extremely rare in these glands. Sublingual glands have an abbreviated duct system. The intralobular ducts are difficult to locate. The lobar ducts often open directly onto the floor of the mouth. The product is a thick mucus rich secretion with a low enzyme content.

13.6. The Teeth/Dentes

Humans have a variable or heterodontic dentition meaning that we have teeth of differing shapes designed to do different tasks. Humans have two sets of teeth: deciduous (20) and secondary (32).

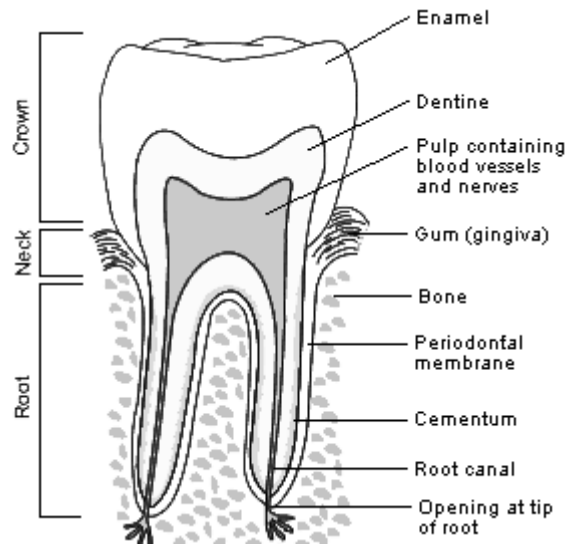


Fig.13.2. Structure of the Teeth

The various shapes and sets of teeth have the same basic structure:

1) Crown - the exposed portion of the tooth which projects above the gingivae. The crown is covered by two extremely hard materials: Enamel and Dentine; that surround a loose connective tissue filled cavity called the Pulp Cavity. Enamel is restricted to the crown but dentin covers the entire tooth.

2) Root - one to three in number these are conical projections which penetrate into the sockets of the mandible and maxilla. The root has narrow channels to allow for the passage of blood vessels and nerves to and from the crown called Root Canals. At the apices of the roots are openings called the Apical Foramen. Covering the dentin of the root is an adhesive material called Cementum that attaches to periodontal ligaments to the tooth.

3) Cervix/Neck - a narrow portion between the roots and crown.

13.7. The Basic Histology of the Digestive Tube

The histology of the entire digestive tube demonstrates a basic pattern. The wall is composed of four concentrically arranged layers enclosing the lumen: tunica mucosa, tunica submucosa, tunica muscularis, and tunica serosa.

1) The Tunica Mucosa - is the innermost layer being in direct contact with the lumen. It consists of three layers: A lining of epithelium which may be specialized for protective functions (ex; esophagus) or for absorption and secretion (ex; stomach). Typically the epithelium is a simple columnar. A lamina propria surrounds the epithelium. The lamina propria will be rich in reticular fibers and lymphoid cells. It will support the epithelial layer and functions immunologically. The third layer is a sheet of smooth muscle called the Muscularis Mucosa. Contraction of the muscularis mucosa causes folding of the mucosa.

2) The Tunica Submucosa - is the second layer. The tunica submucosa is a relatively thick layer of loose connective tissue containing lymph vessels, blood vessels, lymphoid nodules, and a nerve plexus. The nerve plexus is an autonomic plexus called the Submucosal Plexus which controls the muscularis mucosa. Although a loose connective tissue, the fiber content is fairly high and variable in this tunic.

3) The Tunica Muscularis/Muscularis Externa - is the third tunic. This tunic will typically consist of two sheets of smooth muscle. The inner sheet is arranged circularly, the outer sheet is arranged longitudinally. Between the two sheets is a sparse connective tissue layer containing an ANS nerve plexus called the Myenteric Plexus. This nerve plexus controls the tunica muscularis. The tunica muscularis is greatly modified in the upper esophagus, colon, and stomach.

4) The Tunica Serosa - is the outermost tunic. Typically the tunica serosa is a serous membrane being composed of mesothelium resting on a thin layer of loose connective tissue. It is also known as the Visceral Peritoneum and is contiguous with the Parietal Peritoneum which lines the walls of the abdominopelvic cavity. This is the case for all of the organs of the digestive tube located inferior to the diaphragm. Most of the esophagus is superior to the diaphragm and so is not covered by the visceral peritoneum. Instead those portions superior to the diaphragm are covered by a loose connective tissue which attaches the esophagus to surrounding structures. The outermost tunic of these portions of the esophagus is called the Tunica Adventitia.

13.8. The Esophagus

The esophagus is a muscular, collapsible tube which conveys the bolus from the pharynx to the stomach by means of peristaltic contractions. It can be considered to be the start of the digestive tube proper since it is the first organ to have the four tunic arrangement.

a) Tunica Mucosa

The tunica mucosa of the esophagus has an epithelium of stratified squamous, nonkeratinized type. The lamina propria is rich in lymphoid cells and will have occasional lymph nodules. At the lower margins of the esophagus Esophageal Cardiac Glands may be present in the lamina propria. The occurrence of these glands is subject to a high degree of individual variation ranging from abundant to absent. They are located near the Gastroesophageal/Cardiac/Lower Esophageal Junction. The esophageal cardiac glands are compound tubular glands which secrete mucus to protect the esophagus from acid reflux. The muscularis mucosa is formed by longitudinally oriented smooth muscle cells supported by delicate elastic fibers.

b) Tunica Submucosa

The submucosa consists of a loose connective tissue having a dense collagenous and elastic fiber framework that is very plastic and resilient. Esophageal Glands proper/Deep Esophageal Glands are located in the submucosa and have ducts which open onto the epithelial surface. They are mucus secreting glands which lubricate the passage of the bolus. The submucosa, along with the mucosa, will be arranged into folds to allow for greater distension during swallowing.

c) Tunica Muscularis

The tunica muscularis of the esophagus is unique being composed of both skeletal and smooth muscle fibers under ANS innervation. The upper third of the esophagus has both the circular and longitudinal layers of the muscularis externa composed of skeletal muscle. In the middle third smooth muscle begins to replace skeletal muscle. The lower third of the esophagus has both the circular and longitudinal layers of the muscularis externa composed of smooth muscle. Innervation of the tunica muscularis comes from the vagus nerve (parasympathetic) and both the cervical and thoracic trunks (sympathetic).

d) Tunica Adventitia

The outermost tunic for most of the esophagus is not a tunica serosa but instead a tunica adventitia. The tunica adventitia is a loose connective tissue sheath that connects the esophagus to neighboring structures. A short portion of the esophagus does penetrate the diaphragm and enter into the abdominopelvic cavity. This terminal portion is covered by a tunica serosa as is all of the digestive tube in the abdominopelvic cavity.

13.9. The Stomach

The stomach is an expansion of the digestive tube that originally served to store food. In mammals it serves both to store and to digest food. The food enters the stomach as the semisolid bolus and is exposed to chemical and mechanical forces which reduce it to a partially digested fluid mass called Chyme. Mechanical digestion is controlled by the myenteric nerve plexus. It causes mixing of the food with digestive enzymes and HCl to promote chemical digestion. It also churns the food to further break it down mechanically, a process called maceration. The stomach produces a variety of secretions collectively called Gastric Juice to allow for the chemical digestion of the bolus. These secretions include the protease pepsin, the glycoprotein gastric intrinsic factor, mucus, and HCl. The primate stomach is divided into four regions:

1) Cardiac Region - the portion of the stomach to receive the bolus from the esophagus and guarded by the Cardiac Sphincter.

2) Fundic Region - the dome shaped region superior to the cardia which serves to store food for up to one hour.

3) Pyloric Region - a narrow segment connecting the stomach to the duodenum and guarded by the Pyloric Sphincter.

4) The Body - the bulk of the stomach it is located between the cardia and pylorus.

When it is empty the stomach's mucosa is arranged into folds called Rugae which allow for more room for distension.

a) Tunica Mucosa

The mucosa of the stomach is divided by a pattern of shallow furrows into small, slightly elevated areas (between 1 to 6 mm in diameter) which have many small Gastric Pits (also called Foveolae). The gastric glands will open into these gastric pits. The mucosa of the stomach is composed of: tall, simple columnar epithelium, This epithelium lines the gastric glands. These cells are characterized by an apical mucus cap. This mucus cap is secreted by mucus cells onto the epithelial surface so as to form a barrier against the acidic contents of the stomach. This is the typical epithelium of the digestive tube. a lamina propria which is typically lymphoid, It supports both the surface epithelium and the numerous gastric glands which open into the gastric pits. These glands are simple or branched tubular glands and vary in cellular composition and function depending on their location in the stomach. Three types of gastric glands can be identified: cardiac, pyloric, and fundic glands. The gastric pits and the gastric glands are invaginations into the lamina propria from the surface epithelium. and the standard muscularis mucosa, although it is well pronounced.

b) The Glands of the Stomach

1) Fundic Glands/Gastric Glands

These glands are located in the body and fundic regions of the stomach. They are the

most important secretors of gastric juice. Several fundic glands may open into the same gastric pit. Each gland may divide into two or three branches at its terminal end. There are four cell types in the fundic gland.

i] Chief Cells/Zymogenic Cells: Chief cells are simple cuboidal or low columnar epithelial cells found in the lower third or lower third of the gastric gland. Chief cells produce Pepsinogen, the precursor to Pepsin. Pepsin is a protease which breaks polypeptides down into peptide subunits. Pepsin is activated by the low pH of the stomach. During digestion the stomach has a pH of 1.8.

ii] Parietal Cells/Oxyntic Cells: Parietal cells are large pyramidal shaped cells found lining the upper half of the gastric gland. Under the electron microscope parietal cells display secretory canaliculi. Secretory canaliculi are invaginations of the cell membrane lined by microvilli for the secretion of cellular products. Parietal cells produce hydrochloric acid and gastric intrinsic factor. HCl causes the low pH of the stomach which activates pepsin. Gastric intrinsic factor is a glycoprotein which facilitates the absorption of vitamin B₁₂ by the small intestine.

iii] Mucus Neck Cells: Mucus neck cells are columnar epithelial cells found among the parietal cells. They produce mucus.

iv] Argentaffin Cells/Enteroendocrine Cells: Argentaffin cells are small granulated cells of wide distribution. They are particularly prevalent in the pyloric region of the stomach but they are also found in the large intestine, small intestine, pancreas, and liver. Argentaffin cells are hormone producing cells. They are part of the A.P.U.D. (the amine precursor uptake and decarboxylation) system. They are part of the diffuse endocrine system, a group of endocrine cells distributed throughout several organ systems. They produce a variety of hormones and vasoactive amines such as:

- (1) Gastrin - which increases gastric motility and the production of HCl and pepsinogen.
- (2) Somatostatin - which inhibits the function of gastrin and several other gastric hormones.
- (3) Insulin - promotes the storage of glucose as glycogen.
- (4) Glucagon - promotes the release of glucose from glycogen.
- (5) Histamine - which stimulates gastric secretion and increase vascular permeability.
- (6) Serotonin - which inhibits gastric secretion and is a powerful vasoconstrictor.

2) Cardiac Glands

These glands are located in the cardiac region. These glands are relatively short as are the gastric pits which they open into. Cardiac glands contain primarily mucus neck cells but will also have some argentaffin cells. Chief and parietal cells are absent in cardiac glands.

3) Pyloric Glands

These glands are located in the gastric pits of the pyloric region. These pits are deeper and their glands are longer and more branched and coiled than are the cardiac glands. The cellular content of the pyloric glands is similar to that of the cardiac glands except for the higher argentaffin cell content.

1) Tunica Submucosa

The tunica submucosa is similar to that of the esophagus.

2) Tunica Muscularis

The tunica muscularis of the stomach is modified to increase its role in mechanical digestion. It has three sheets of smooth muscle, as opposed to the normal two sheets. The

outer sheet is longitudinally arranged. The middle sheet is circularly arranged. The inner sheet is obliquely arranged.

3) Tunica Serosa

The tunica serosa is the visceral peritoneum and the typical outer tunic of the digestive tube.

13.10. The Small Intestine

13.10.1. General Contents

Chyme arriving in the small intestine from the stomach is subject to a very different environment. The digestive juices of the small intestine are alkaline and contain a wide array of hydrolytic enzymes. The bulk of chemical digestion occurs in the small intestine. Prior to entering the small intestine: Some carbohydrates have been reduced to disaccharides. But the disaccharides must still be reduced to monosaccharides to cross the intestinal epithelium and polysaccharides remain in the chyme. Some proteins have been broken down into peptides. But the peptides must be degraded into amino acids and polypeptides remain in the chyme. Lipids have not begun to be digested. Nucleic acids have not begun to be digested. The alkaline nature of intestinal juice provides the correct pH for the enzymes (~7.8) and helps to neutralize the acidity of the chyme.

The small intestine also performs the bulk of the absorption of nutrients. Only simple sugars, salts, and water will have been absorbed prior to the small intestine. This is why the small intestine is the longest segment of the digestive tube at 7 m and has numerous modifications of the luminal surface. The small intestine can be divided into three segments: duodenum, jejunum, and ileum (running from the pyloric sphincter to the ileocolic sphincter). The wall of the small intestine will have modifications of the mucosa and submucosa designed to increase surface area so as to increase the absorption of nutrients:

- 1) Plicae Circularis - crescentic folds of the mucosa and submucosa which causes the chyme to spiral through the lumen.
- 2) Villi - finger like folds of the mucosa. They range from 0.5 to 1.5 mm in length. They are very numerous averaging between 10 to 40 villi per square mm. They will have a core of loose connective tissue rich in capillaries and containing a lymph vessel called the Lacteal. They greatly increase the surface area for the absorption of nutrients.
- 3) Microvilli - finger like extensions of the apical cell membrane of the intestinal epithelial cells. They greatly increase the surface area for the absorption of nutrients.
- 4) Intestinal Crypts/Crypts of Leiberkuhn - invaginations of the intestinal epithelium into the underlying lamina propria to the level of the muscularis mucosa. The intestinal crypts form tubular glands also called Intestinal Glands.

13.10.2. Tunica Mucosa

The tunica mucosa of the small intestine is lined by a tall simple columnar epithelium.

The cell types present vary in the different portions of the intestinal epithelium:

1) Epithelial Cells of the Villi - there are three cell types present in the villus:

a) Columnar Absorptive Cells - these columnar epithelial cells have a well developed "striated border" of microvilli. The plasma membrane is covered by a surface coat of branching glycoproteins. This glycoprotein surface coat has two functions: to protect the cell from proteolytic and mucolytic agents, and to provide binding sites for the absorption of specific nutrients. The enzymes catalyzing the final breakdown of proteins (peptidases)

and carbohydrates (disaccharidases) are located in the membrane of the microvilli. Their end products will be absorbed across the intestinal epithelium.

b) Goblet Cells - mucus producing cells considered to be unicellular mucus glands. The mucus serves to lubricate and protect the epithelium.

c) Argentaffin Cells/Enteroendocrine Cells - hormone secreting cells similar in appearance and function to those found in the stomach and large intestine. Argentaffin cells produce a variety of peptide hormones:

i) Enteroglucagon - causes glucagon secretion.

ii) Serotonin - inhibits gastric secretion and is a vasoconstrictor.

iii) Secretin - controls the secretion of the accessory digestive organs.

iv) Pancreozymin/Cholecystokinin - controls the secretion of the accessory digestive organs.

v) Motilin - increases smooth muscle contractions.

vi) Neurotensin - decreases smooth muscle contractions and modulates glucoregulatory systems.

2) Epithelium Lining the Intestinal Crypts - is continuous with the epithelium lining the villi and includes the above mentioned three types of cells plus two additional types found at the bottom of the crypts:

a) Undifferentiated Stem Cells - located at the base of the crypts these cells will undergo mitosis to replace cells lost from the villi. They will migrate from the bottom of the crypt to the villus. During their normal life cycle, they will later be shed. The life cycle lasts about five days. They are pluripotent cells.

b) Paneth Cells - these columnar cells are found in groups at the base of the crypts. They are large cells with abundant secretory granules. These granules are eosinophilic. The functions of these granules are still undetermined but one product which has been identified is Lysozyme. The lamina propria fills the spaces between the crypts and forms the cores of the villi. It resembles the reticular connective tissue of the lymphoid organs in fiber content and in its high cellular content. Within the fiber framework are found large numbers of eosinophils, plasma cells, lymphocytes, and macrophages. Many of the plasma cells have been shown to produce IgA which passes onto the luminal surface for protection against bacteria. Isolated lymph nodules are found throughout the lamina propria of the small intestine. They reach their greatest numbers in the ileum where groups of nodules form Peyer's Patches. Each Peyer's patch consists of between 30 to 40 nodules. The muscularis mucosa is the typical but also is reflected into thin strands of smooth muscle in the lamina propria of the intestinal villi. The smooth muscle of the villus will surround a lacteal. Contractions of this smooth muscle facilitates the movement of lymph in the lacteal.

10.13.3. Tunica Submucosa

The submucosa is high in fiber content being **almost** a dense irregular c.t. In the duodenum the submucosa contains large mucus glands called Submucosal Glands/Brunner's Glands. These glands secrete an alkaline mucus which neutralizes the acidity of the chyme. So they are particularly prevalent closer to the pyloric sphincter. The alkaline nature of this mucus also helps in digestion. The submucosal glands are actually deep invaginations of the surface epithelia.

10.13.4. Tunica Muscularis

The tunica muscularis is made up of the typical two smooth muscle sheets as is standard

for the digestive tube.

10.13.5. Tunica Serosa

The tunica serosa is made up of the typical mesothelium resting on a thin layer of loose connective tissue as is standard for the digestive tube.

13.14. The Large Intestine

13.14.1. General Contents

The main functions of the large intestine is the absorption of water and minerals, converting the residual chyme to feces, and eliminating the feces. Certain vitamins are absorbed by the large intestine. In particular, vitamin K which is produced by the resident *E. coli*. Although the colon can absorb amino acids, nearly all of the absorption of nutrients occurs in the small intestine. As a result, many of the modifications to increase surface area found in the small intestine are lacking in the large intestine. It lacks the plicae circularis and villi. It has a very reduced striated border due to having much shorter microvilli on the columnar epithelial cells. The intestinal crypts, however, are well developed and are quite deep. Although they lack paneth cells and have more goblet cells than do the crypts of the small intestine. Secretion in the large intestine is limited to a viscous fluid with a high mucus content which acts as a lubricant for the passage of the feces. The large intestine is much shorter than is the small intestine being 1.5 m long. It is named for its greater diameter due to the decreased need for absorption. There are four parts to the large intestine, beginning at the ileocolic sphincter and extending to the anal sphincter:

- a) Cecum - a blind pouch located at the ileocolic junction. It has the vermiform appendix attached to it.
- b) Colon - the longest segment extending from the ileocolic junction to the rectum.
- c) Rectum - a short segment that stores the feces prior to elimination.
- d) Anal Canal - a short passageway for the elimination of the feces

12.14. 2. The Histology of the Colon

a) Tunica Mucosa

The epithelium of the mucosa is a simple columnar type. It has columnar absorptive cells, goblet cells, argentaffin cells, and undifferentiated stem cells. The undifferentiated stem cells are limited to the bases of the crypts. The number of goblet cells increases in the lower portions of the colon to lubricate the passage of the increasingly dehydrated feces. The lamina propria and muscularis mucosa are structurally similar to that of the small intestine. Lymphatic nodules will continue to occur and will even push into the submucosa through the muscularis mucosa.

b) Tunica Submucosa

The tunica submucosa is similar to that of the small intestine.

c) Tunica Muscularis

The tunica muscularis of the colon does show some modification. The outer, longitudinal, sheet is arranged into three flat bands (instead of as a continuous sheet) called the *Teniae Coli*. This causes the colon to be organized into segments called Haustra. The teniae coli is lost at the level of the rectum and the continuous longitudinal sheet resumed.

d) Tunica Serosa

The tunica serosa is similar to that of the small intestine and stomach.

14.14.3. The Rectum and the Anal Canal

The rectum and anal canal are modified portions of the large intestine designed for the storage and elimination of the feces. In the rectum the crypts are fewer and deeper. The crypts will hold mucus producing glands called Anal Glands. Also the teniae coli is lost. In the anal canal the mucosa assumes longitudinal folds called the Columns of Morgagni/Anal Columns. The epithelium is a stratified squamous, nonkeratinized, type. The anal crypts are shallower and the number of anal glands increases. The anus is actually two sphincters. The internal sphincter is composed of smooth muscle. The external sphincter is composed of skeletal muscle.