Inderbir Singh's Textbook of

HUMAN HISTOLOGY

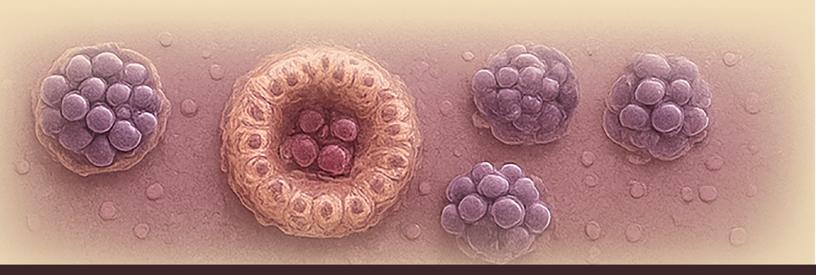
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II th Edition

A Clinically Integrated Approach with Case Scenarios & Clinical Applications



Revised by

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Foreword

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CHAPTER

16

Gastrointestinal Tract, Stomach and Intestines

COMPETENCY ADDRESSED

AN52.1: Describe general plan of gastrointestinal system and identify the microanatomical features: Esophagus; fundus of stomach; pylorus of stomach; duodenum; jejunum; ileum; large intestine; appendix.



Case Scenario

A 22-year-old male presents to the emergency department with a five-day history of fever and abdominal pain. He mentions attending a village fair recently. Additionally, he complains of severe weakness, worsening stomach pain, headache, diarrhea, and loss of appetite. Upon abdominal examination, tenderness is noted around the umbilicus. His complete blood count reveals an elevated white blood cell count, and the Widal test returns positive, confirming the diagnosis of typhoid fever. The Peyer's patches are infected in this condition causing ulcers parallel to longitudinal axis of ileum. The composition of each layer, is crucial for correlating pathophysiology with associated conditions. This knowledge facilitates more efficient management strategies for gastrointestinal disorders.

INTRODUCTION

- The gastrointestinal tract (GIT) or alimentary canal is a long muscular tube lined by mucous membrane and extends from oral cavity and to anus.
- GIT includes esophagus, stomach, duodenum, jejunum, ileum, colon, rectum and anal canal. There are several accessory organs that form part of the alimentary system. These include the structures of the oral cavity (lips, teeth, tongue, and salivary glands), liver, and pancreas.
- The abdominal part of the alimentary canal (consisting of the stomach and intestines) is often referred to as the gastrointestinal tract.
- Structure of the organs are specialized to perform different functions like secretion, protection, and absorption in different parts of the GIT.
- The organs are specialized for digestion, absorption and protection.

GENERAL STRUCTURE OF GIT

- The structure of the alimentary canal, from the esophagus up to the anal canal is in the form of fibromuscular tube and the tube conforms a general plan.
- The wall of the tube is made up of the following layers from within outwards: mucosa, submucosa, muscularis externa and adventitia/serosa (Fig. 16.1).

Mucosa

- The mucous membrane is made up of: (a) Lining epithelium, (b) Lamina propria, and (c) Submucosa.
- Primarily, it is the mucosa in which changes are seen in the alimentary tract; the other layers remain almost the same.

Lining Epithelium

- The lining epithelium is columnar all over the gut; except in the esophagus, and in the lower part of the anal canal, where it is stratified squamous. This stratified squamous epithelium has a protective function in these structures and the columnar epithelium are either secretory (stomach) or absorptive (small intestine).
- The epithelium of the gut presents an extensive absorptive surface. The factors contributing to the increase in the surface are:
 - Plica circularis: The presence of numerous folds involving the entire thickness of the mucous membrane. These folds can be seen by naked eye. The submucosa extends into the folds (plica circularis of small intestine).
 - *Crypts:* At numerous places the epithelium dips into the lamina propria forming **crypts**.

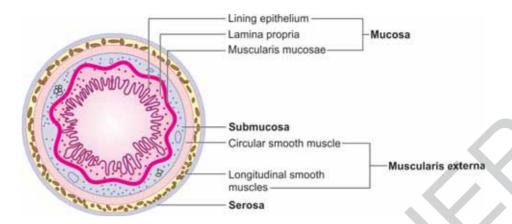


Fig. 16.1: Layers of the wall of GIT.

- Villi: In the **small intestine**, the mucosa bears numerous finger-like processes that project into the lumen called **villi**.
- *Microvilli:* The luminal surfaces of the epithelial cells bear numerous **microvilli**.
- Lining epithelium is also specialized to provide secretory function. The secretory cells are arranged in the form of numerous glands as follows:
 - Some glands are unicellular, the secretory cells being scattered among the cells of the lining epithelium.
 - In some organs, the epithelium dips into the lamina propria forming simple tubular glands.
 - In other structures (e.g., in the esophagus, duodenum) there are **compound tubuloalveolar glands** lying in the submucosa. They open into the lumen of the gut through ducts traversing the mucosa.
 - Finally, there are **complete glands**—salivary glands, pancreas, and liver that form distinct organs lying outside the gut wall. They pour their secretions into the lumen of the gut through large ducts.

Lamina Propria

- The lamina propria is made up of loose connective tissue with collagen, reticular and in some site's elastic fibers, embedded in a glycosaminoglycan matrix.
- Some fibroblasts, blood capillaries, lymph vessels, and nerves are seen in this layer.
- It surrounds and supports glandular elements and the overlying epithelium. In the small intestine, the lamina propria forms the core of each villus.
- Mucosal glands extend into lamina propria of the gut and are readily seen in certain organs like esophagus and anal canal. They mainly lubricate the mucosa and protect it from chemical injury.

 Prominent aggregations of lymphoid tissue as well as scattered lymphocytes are present in the lamina propria.
 Some of this lymphoid tissue extends into the submucosa called as gut-associated lymphoid tissue (GALT).

Muscularis Mucosae

- This is a thin layer of smooth muscle that separates
 the connective tissue of the lamina propria from the
 submucosa. It consists of two thin layers of smooth
 muscles, an inner circularly arranged and an outer
 longitudinally arranged layer.
- The muscularis mucosa extends into mucosal folds, but not into villi for milking action and side to side movements of villi.
- Contractions of the muscularis mucosae are important for the local mixing of intestinal contents and facilitate absorption and secretion.

Submucosa

- It consists of dense irregular connective tissue and connects the mucosa to the muscularis externa.
- It contains large blood vessels, lymphatics, and nerve fibers.
- The large blood vessels send smaller branches to mucous membrane, muscularis externa, and serosa.
- The nerves form a submucosal plexus of unmyelinated nerve fibers and ganglion cells, and constitute the Meissner's plexus in submucosa. Unmyelinated nerve fibers are postganglionic sympathetic fibers from superior mesenteric plexus.
- Submucosal glands are present in the esophagus and proximal part of duodenum (Brunner's glands).

Muscularis Externa

- The muscularis externa consists of smooth muscle except at the upper part of the esophagus and anal canal where this layer contains striated muscle fibers.
- The muscle layer consists of an inner circular and an
 outer longitudinal layer separated by thin layer of
 connective tissue. Both layers consist of spirally arranged
 fasciculi, the turns of the spiral being compact in the
 circular layer and elongated in the longitudinal layer.
- In the stomach, an additional inner oblique layer of muscle is present to help mixing of gastric contents. In the colon, the longitudinal fibers are gathered to form prominent bundles called the **taenia coli**.
- Localized thickenings of circular muscle fibers form sphincters like pyloric sphincter around the pyloric end of the stomach, and the internal anal sphincter surrounds the anal canal. A functional sphincter is seen at the junction of the esophagus with the stomach. A valvular arrangement at the ileocecal valve prevents regurgitation of cecal contents into the ileum.
- Thin layer of connective tissue contains plexus of nerves called Myenteric plexus/Auerbach's plexus.
 It also contains blood vessels and lymphatics.
- **Function:** Contraction of muscles in this layer helps in mixing and propulsion of luminal contents by slow rhythmic movement called **peristalsis**.

Serous or Adventitia

- It is the loose supporting tissue and outermost layer of the gut, covering the muscle coat.
- It is a serous membrane lined by simple squamous epithelium called mesothelium and minimal amount of connective tissue. This layer is nothing but visceral peritoneum that covers most parts of the gastrointestinal tract and extends over the abdominal wall to form parietal peritoneum.
- Large blood vessels, lymphatics, and nerve trunk traverse through serosa.
- In some places where a peritoneal covering is absent (e.g., thoracic part of the esophagus, duodenum, etc.) the muscle coat is covered by an adventitia made up of connective tissue only.

Nerve Plexuses

The gut is richly innervated by autonomic nervous system (enteric nervous system) and the nerve fibers form two distinct plexus:

- The submucosal plexus of Meissner, that lies in the submucosa and has only parasympathetic fibers which are secretomotor.
- The myenteric plexus of Auerbach, which lies between the circular and longitudinal coats of muscularis externa has both sympathetic and parasympathetic fibers but only cell bodies of parasympathetic neurons.
- These plexuses are both under intrinsic and extrinsic control. Nerve fibers in these plexuses are both afferent and efferent.

ESOPHAGUS

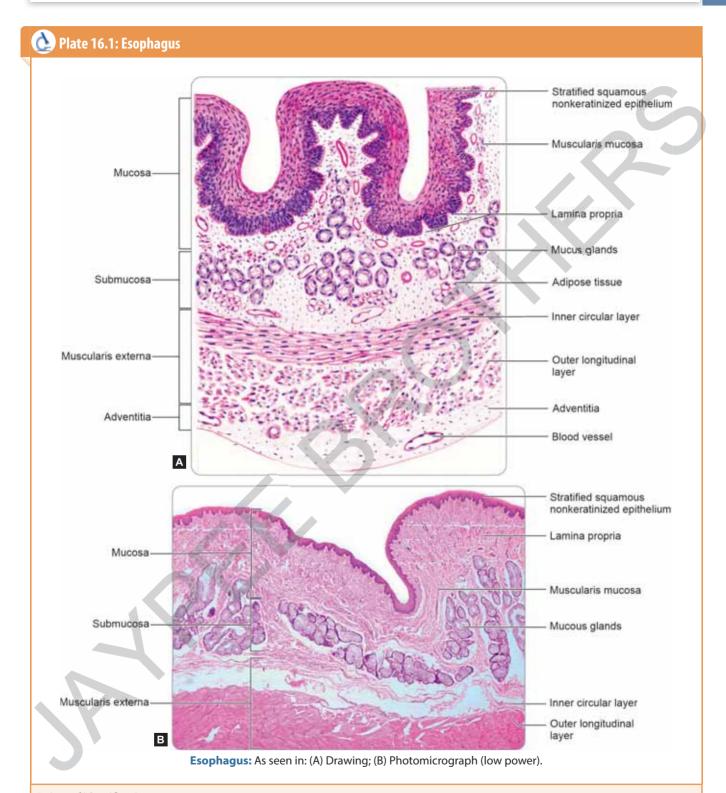
- The esophagus is a narrow and long muscular tube, 25
 cm in length extends from pharynx and opens into the
 cardiac end of stomach. It consists of cervical, thoracic
 and abdominal parts. The esophagus shows constrictions
 due to anatomical structures at four levels.
- Function: It conducts chewed food (bolus) and liquids to stomach. No other function of the GIT is seen in esophagus.
- The lumen is collapsed hence contains longitudinal folds and opens when the food bolus passes through it.

Microscopic Features

The wall of esophagus (Plate 16.1) has the usual four layers: (1) mucosa, (2) submucosa, (3) muscularis externa, and (4) adventitia except over a short length near its lower end.

Mucosa

- The mucous membrane of the esophagus shows several longitudinal folds that disappear when the tube is distended.
- Lining epithelium: The mucosa is lined by stratified squamous nonkeratinized epithelium, at the gastroesophageal junction, there is a transition of epithelium from stratified to simple columnar.
- Lamina propria: Finger-like processes (or papillae) of the connective tissue of the lamina propria project into the epithelial layer (just like dermal papillae). This helps to prevent separation of epithelium from underlying connective tissue.
- Glands: At the upper and lower ends of the esophagus, some tubuloalveolar mucus glands are present in the lamina propria which are called as esophageal cardiac glands. They protect from the regurgitated acid contents of stomach.



- Four layers of gastrointestinal tract (GIT): Mucosa, submucosa, muscularis externa, adventitia seen.
- Lining epithelium is stratified squamous nonkeratinized epithelium.
- Submucosa is studded with mucus-secreting esophageal glands.

- **Function:** Stratified epithelium and mucus secretion from esophageal glands provides protection during passage of food.
- Muscularis mucosae are made of longitudinally oriented smooth muscle fibers which are thick in the upper end of the esophagus and help in swallowing.

Submucosa

- The special feature of the submucosa is the presence of compound tubuloalveolar mucus glands called esophageal glands proper, more concentrated in the upper half of the esophagus. They help to lubricate the luminal wall.
- Small aggregations of lymphoid tissue may be present in the submucosa, especially near the lower end. Some plasma cells and macrophages are also present.

Muscularis Externa

- Consists of inner circular and outer longitudinal layers.
- In the upper third of the esophagus, it is made of only skeletal muscle fibers, in the middle third, it is a combination of both smooth muscle and skeletal muscle fibers and in the lower third, it is made up of only smooth muscle fibers like the rest of the GIT.
- The circular muscle layer covers the whole tube and continuous with circular layer of stomach without forming anatomical sphincter, but physiological sphincter exists at this site.
- Myenteric plexus is present between outer and inner muscular layer which produces peristalsis in proximodistal direction, by stimulating muscularis externa.

Adventitia

- The muscle layer of the esophagus is surrounded by dense fibrous tissue that forms an adventitial coat for the esophagus.
- The lowest part of the esophagus is intra-abdominal and has a covering of peritoneum, hence serosa.

STOMACH

- Stomach is a hollow muscular organ that receives food bolus from esophagus and most dilated part of GIT.
- The food passes through the esophagus and enters the stomach where it is converted into a thick paste known as chyme.

- Anatomically, stomach is divided into four regions: (1) cardia, (2) fundus, (3) body, and (4) pylorus (Fig. 16.2).
- Histologically, fundus and body of stomach have a similar structure

Functions

- It acts as temporary reservoir of food.
- Secretes copious amount of mucus, so that prevents autodigestion of the tissues.
- Helps in digestion of proteins, absorption of water, glucose, and few salts.
- Acidic environment of stomach provides protection against microbes.
- Intrinsic factor secreted in the stomach aids in absorption
 of vitamin B₁₂. Secrets gastrin by pyloric glands which
 regulates secretion of HCl and pepsin.

Microscopic Features

The wall of the stomach has the four basic layers (Plates 16.2 and 16.3) from within outward they are: mucous membrane, submucosa, muscularis externa, and serosa.

Mucous Membrane

- As seen with the naked eye (Fig. 16.3), the mucous membrane is thick, soft, and velvety, presents numerous vertical folds or rugae that disappear when the stomach is distended.
- Mucous membrane consists of lining epithelium, supported by lamina propria and muscularis mucosa.

Lining epithelium

• It is honey-comb appearance and at numerous places, the lining epithelium dips into the lamina propria and forms

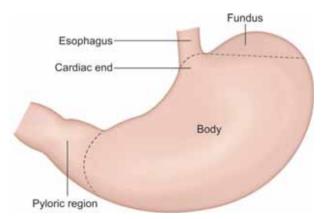
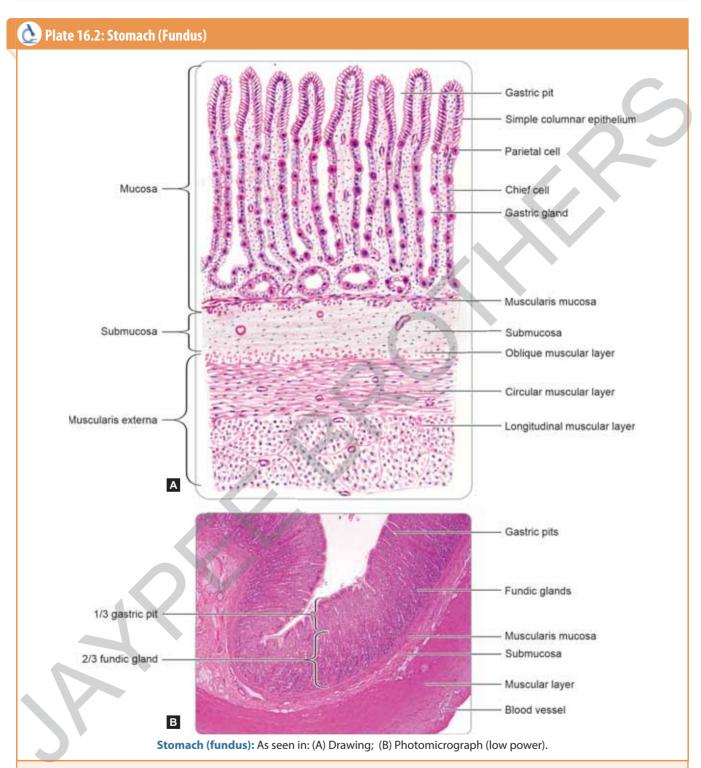
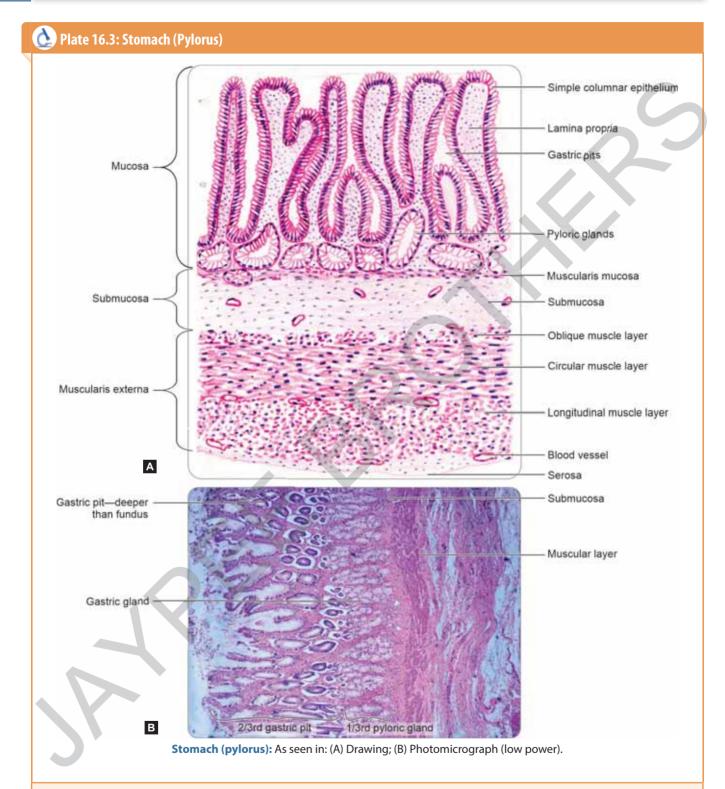


Fig. 16.2: Anatomical regions of stomach (schematic presentation).



- Presence of four layers—mucosa, submucosa, muscularis externa, and serosa.
- Shallow gastric pits occupying superficial one-fourth or less of the mucosa.
- Presence of gastric glands in the mucosa.
- Gastric glands with numerous oxyntic cells which give beaded appearance.



- Presence of four layers—mucosa, submucosa, muscularis externa, and serosa.
- Deep gastric pits occupying two-thirds of the depth of the mucosa.
- Presence of pyloric glands (mucus glands) in the mucosa that are simple/branched tubular glands which are coiled.

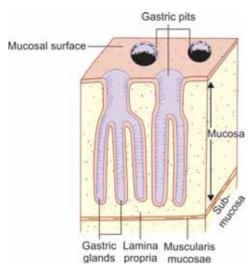


Fig. 16.3: Basic structure of the mucous membrane of the stomach (schematic presentation).

numerous depressions called **gastric pits** (Fig. 16.3), which receive the ducts of gastric glands.

- The surface and pits are lined by simple columnar epithelium resting on basement membrane. They are mucus-secreting cells with apical large mucin granules which are usually removed during processing of tissues so that the cells look empty (or vacuolated).
- Mucus secreted by cells of the lining epithelium protects the gastric mucosa against acid and enzymes produced by the mucosa itself.
- Deep to the gastric pits, the mucous membrane is packed with numerous gastric glands. Depending on their presence in different regions of stomach, these glands are of three types: Gastric (fundic), cardiac, and pyloric.

Gastric glands

- The main gastric glands are present over most of the stomach except in the pyloric region and in a small area near the cardiac end.
- Though they are synonymously called as **fundic glands**, they are also present in the body of the stomach.
- Simple or branched tubular glands that lie at right angles to the mucosal surface.
- Fundic glands consists of isthmus, neck and base from superficial to deep.
- Open into gastric pits, each pit receiving the openings of several glands. Here the gastric pits occupy the superficial one-fourth or less of the mucosa, the remaining thickness being closely packed with gastric glands.

The following types of cells are present in the epithelium lining the glands.

A. Chief cells/peptic cells/zymogen cells

- They are most numerous cells particularly in the basal parts of the glands and the cells are cuboidal or low columnar with basal nuclei and basophilic cytoplasm.
- The cells contain prominent secretory granules in the apical parts of their cytoplasm and granules contain a precursor of pepsin called pepsinogen.
- With the EM, the cytoplasm is seen to contain abundant rough endoplasmic reticulum and a prominent Golgi complex and luminal surfaces of the cells bear small irregular microvilli.
- Chief cells secrete the digestive enzymes of the stomach including pepsin. Pepsin is produced by action of gastric acid on pepsinogen which breaks down proteins into small peptides. It is mainly through the action of pepsin that solid food is liquefied.

B. Oxyntic cells/parietal cells (Fig. 16.4)

- They are large or polyhedral, with a large central nucleus, eosinophilic cytoplasm due to presence of numerous mitochondria.
- The luminal part of cells has intracellular canaliculi with short microvilli that project into the lumen of canaliculi.
- They are more numerous in the upper half of the gland (isthmus) than in its lower half. They are present

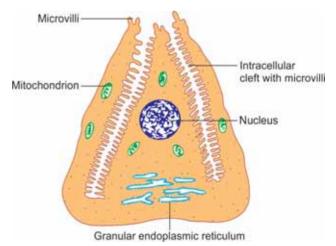


Fig. 16.4: Electron microscope structure of an oxyntic cell (schematic presentation).

- singly, sandwiched between peptic cells and basement membrane.
- They are called oxyntic cells because they stain strongly with eosin and called parietal cells as they lie against the basement membrane, and often bulge outward into the lamina propria creating a beaded appearance.
- The EM shows that each parietal cell has a narrow apical part that reaches the lumen of the gland. The apical cell membrane shows several invaginations into the cytoplasm, producing tortuous intracellular canaliculi that communicate with the glandular lumen. The walls of the canaliculi bear microvilli that project into the canaliculi. The cytoplasm (in the intervals between the canaliculi) is packed with mitochondria. The mitochondria are responsible for the granular appearance and eosinophilia of the cytoplasm (seen with the light microscope). Secretory granules are not present.
- Oxyntic cells secrete hydrochloric acid and an intrinsic factor of Castle a glycoprotein that combines with vitamin B₁₂ and is necessary for absorption of vitamin in terminal ileum.
- C. Mucus neck cells: They are large cells with a clear cytoplasm found near the upper end or "neck" of the glands with flattened nucleus pushed to the base because of accumulation of mucus and supranuclear part of the cell contains prominent granules.

D. Endocrine cells

- They are flat cells present near the basal parts of the gastric glands that contain membrane bound neurosecretory granules. They do not reach the lumen, but lie between the chief cells and the basement membrane.
- These cells probably secrete the hormone gastrin.

E. Stem cells

- Some undifferentiated cells (stem cells) that multiply to replace other cells are also present.
- They increase in number when the gastric epithelium is damaged and play an important role in healing.

The cells of the stomach are summarized in **Table 16.1**.

Cardiac glands

- These are confined to a cardiac end where gastric pits are shallow and glands are either simple tubular, or compound tubule-alveolar.
- They are mainly mucus-secreting. An occasional oxyntic or peptic cell may be present.

Pyloric glands

- In the pyloric region of the stomach, the gastric pits are deep and occupy two-thirds of the depth of the mucosa.
- The pyloric glands are short and simple or branched tubular glands that are coiled and open into the pits and occupy the deeper one-third of the mucosa.
- The glands are lined by mucus-secreting cells. Among these cells, gastrin secreting G cells called neuroendocrine cells are also present.
- **Epithelial cell renewal:** Mucus cells renewed every 3–5 days, mucus neck cells in every 6 days, chief and enteroendocrine cells are about 60–90 days and parietal cells has longest lifespan approximately 150–200 days.

Lamina propria

- The lamina propria is relatively scanty and restricted to pits and glands.
- Made of reticular fibers with fibroblasts and other connective tissue cells.
- Occasional aggregations of lymphoid tissue are present in it.

Table 16.1: Summary of cells lining the stomach.

	Chief/zymogen cell	Parietal/oxyntic cell	Mucus neck cell	Enteroendocrine cell	Undifferentiated cell/stem cell
Location	Lower 1/3rd of gland	Upper part of the gland	Junction of pit with gland	Bottom of the gland	Neck of the gland
Identifying feature	Cuboidal or low columnar with basal nuclei and basophilic cytoplasm	Large or polyhedral, with a large central nucleus, eosinophilic cytoplasm	Large cells with a clear cytoplasm with flattened nucleus pushed to the base	Flat cells near the basal parts of the glands that do not reach the lumen, but lie between the chief cells and the basement membrane	-
Function	Secrete pepsinogen	Secrete HCl and intrinsic factor	Soluble mucus	Gastrin, serotonine	

Muscularis mucosae

- The muscularis mucosae of the stomach is thin.
- Apart from the usual inner circular and outer longitudinal layers, an additional circular layer may be present outside the longitudinal layer.
- The smooth muscle cells extend into lamina propria and helps in the expulsion of the secretion of gastric glands.

Submucosa

Consists of dense irregular connective tissue with blood vessels, lymphatics, and nerve plexus.

Muscularis Externa

- The muscularis externa of the stomach is well-developed and consists of three layers: inner oblique, middle circular, and outer longitudinal layer.
- The appearance of the layers in sections is, however, highly variable depending upon the part of the stomach sectioned.
 - Longitudinal layer covers the entire organ and is thicker along the curvatures. At the pyloric end, it separates into superficial and deep strata. Superficial strata are continuous with the corresponding layer of duodenum, whereas deep strata forms dilator component of pyloric sphincter. This strata layer helps in expulsion of gastric contents into duodenum.
 - Circular fibers are greatly thickened at the pylorus to form the sphincteric component of pyloric sphincter. This layer retains the gastric content in situ till completion of digestion. Unlike the longitudinal layer, it is not continuous with that of duodenum.
 - Oblique layer present only in the fundus and the body and has inverted "U" shaped loop of smooth muscle fibers covering the adjoining surfaces. Along

- the right side it forms free margin and does not extend to lesser curvature, contraction of which makes the lips of gastric canal and makes the cardioesophageal angle more acute, hence prevents regurgitation of gastric contents into esophagus.
- Both circular and longitudinal layer are continuous with corresponding muscle of esophagus but does not form any anatomical sphincter. The longitudinal layer is continuous with that of duodenum, but circular layer is not continuous because of presence of connective tissue septa.
- Longitudinal muscles help in propulsion, circular muscle retains the content until digestion and oblique muscle mixes the food and converts it into chyme.
- Between the layers of muscles there exists, myenteric/ Auerbach's plexus of nerves.

Serosa

- Gastric serosa is derived from peritoneum and is continuous with the parietal peritoneum of abdominal cavity via greater omentum and visceral peritoneum of liver via lesser omentum.
- But the lesser curvature, greater curvature, and bare area of stomach are devoid of serosa.

Comparison of salient features of mucous membrane at each region of stomach is summarized in **Table 16.2**.

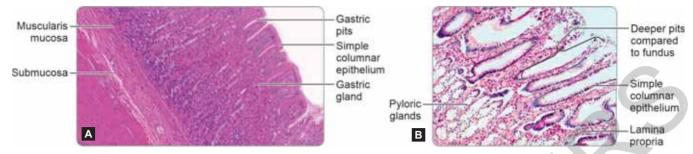
SMALL INTESTINE

Introduction

- The small intestine is a tube about 6 m long extends from stomach to ileocecal junction.
- It is divided into three parts. In the craniocaudal sequence, these are: duodenum, jejunum, and ileum.

Table 16.2: Salient features of mucous membrane at each region of stomach.

Cardia	Fundus and body (Fig. 16.5A)	Pylorus (Fig. 16.5B)
Shallow gastric pits	Shallow gastric pits occupying superficial one-fourth or less of the mucosa	Deep gastric pits occupying two-thirds of the depth of the mucosa
Presence of cardiac glands (mucus secreting glands) in the mucosa	Presence of gastric glands in the mucosa	Presence of pyloric glands in the mucosa
Cardiac glands are either simple tubular, or compound tubuloalveolar	Gastric glands are simple or branched tubular glands. They secrete enzymes and hydrochloric acid	Pyloric glands (mucus glands) are simple or branched tubular glands that are coiled
Change of epithelium from stratified squamous of the esophagus to simple columnar epithelium in stomach	Epithelium is simple columnar	Epithelium is simple columnar



Figs. 16.5A and B: High power magnification showing histological features of (A) Funds and (B) Pylorus parts of stomach.

 Small intestine is essential for life because it is the principal site for absorption of products of digestion. It also secretes some hormones through enteroendocrine cells. Complete digestion of ingested food occurs in small intestine.

Structure (Table 16.3)

- The wall of the small intestine is made up of the four layers from within outwards: mucosa, submucosa, muscularis externa, and serosa (Fig. 16.6).
- The serosal and muscular layers correspond exactly to the general structure of alimentary canal.
- The submucosa is also typical except in the duodenum, where it contains the glands of Brunner.
- The mucous membrane exhibits several special features that are discussed below.

Mucous Membrane

 Mucous membrane is made up of lining epithelium resting on basement membrane, lamina propria, and muscularis mucosa.

Table 16.3: Distinguishing features of duodenum, jejunum, and ileum (**Plates 16.4 to 16.6**).

Duodenum	Jejunum	lleum
Lumen—wider, wall—thicker	Lumen—wider, wall—thicker	Lumen—narrow, wall—thinner
Large, thick circular folds in the lumen	Large, thick circular folds in the lumen	Small, few circular folds in the lumen
Numerous broad villi	Numerous tall villi	Only few, short and slender villi
Mucus-secreting duodenal glands or glands of Brunner	Very few Peyer patches extending into submucosa— only in the distal part	Numerous Peyer's patches extending into mucosa

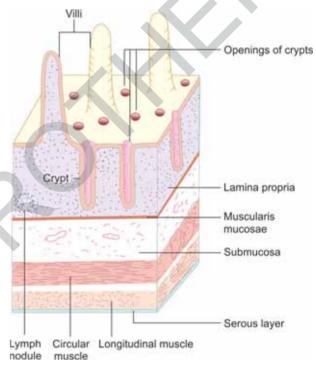
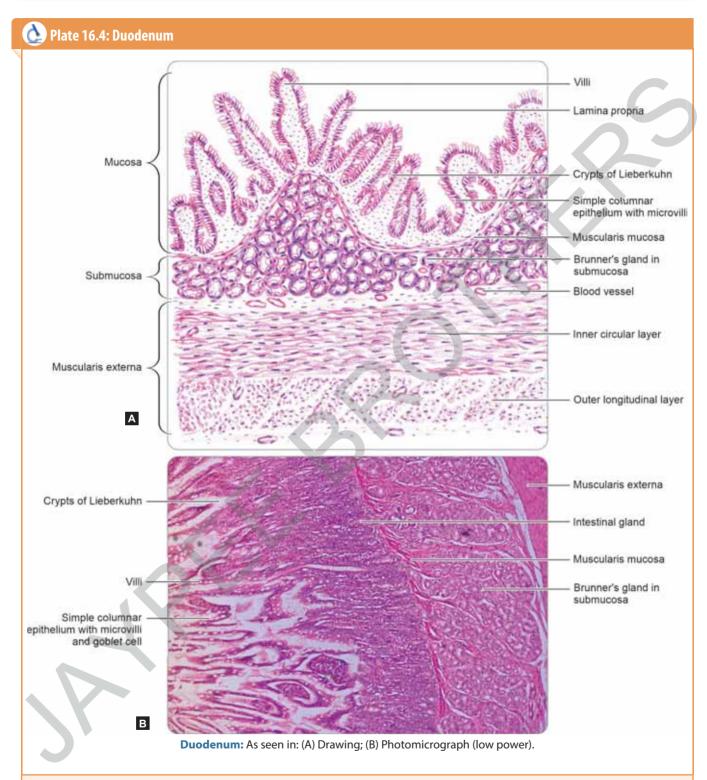


Fig. 16.6: Basic structure of the small intestine (schematic presentation).

- The total absorptive surface of the small intestine is 200 sq meters and this is achieved by the following features:
 - The considerable length of the intestine.
 - The presence of numerous circular folds (plicae circularis) in the mucosa, increase absorptive surface by 3-fold.
 - The presence of numerous finger-like processes called villi, that project from the surface of the mucosa into the lumen increase absorptive surface by 10-fold.
 - The presence of numerous **crypts** that invade the lamina propria.
 - The presence of microvilli on the luminal surfaces of the cells lining the mucosa, increase absorptive surface by 20-fold.



- Wall made up of four layers.
- Mucosa—presence of numerous broad villi, lined by simple columnar epithelium with microvilli and goblet cells.
- Presence of submucous Brunner's gland.

- Very similar cells are also to be seen in the pancreas. All these cells are now grouped together under the term **gastroenteropancreatic endocrine system**.
- Some features of this system are similar to those of amine-producing cells in other organs. All these are included under the term APUD cell system.



APPLIED HISTOLOGY

ESOPHAGUS

- Gastroesophageal reflux disease (GERD): Mucus glands near the gastric end of esophagus help to protect the regurgitated
 gastric content which causes heartburn. If the condition persists for longer time it can cause GERD.
- Barrett's esophagus: It is a premalignant condition in which, following reflux esophagitis, stratified squamous epithelium of the lower esophagus is replaced by columnar epithelium (columnar metaplasia). The condition is seen more commonly in later age and is caused by factors producing gastroesophageal reflux disease.
- Achalasia (cardiospasm): Achalasia of the esophagus is a neuromuscular dysfunction due to which the cardiac sphincter fails to relax during swallowing and results in progressive dysphagia and dilatation of the esophagus (megaesophagus).

STOMACH

- **Gastritis:** The term "gastritis" is commonly employed for any clinical condition with upper abdominal discomfort like indigestion or dyspepsia in which the specific clinical signs and radiological abnormalities are absent. The condition is of great importance due to its relationship with peptic ulcer and gastric cancer.
- Achlorhydria Certain clinical conditions (like autoimmune disorders) can cause achlorhydria, where there is absence of HCl due to damaged gastric mucosa. Achlorhydria can in turn lead to vitamin B₁₂ deficiency due to lack of intrinsic factor.
- Peptic ulcer: This occurs due to peptic digestion of the devitalized mucous membrane with assistance of HCl. It is most common
 along the lesser curvature and pyloric antrum. Food-pain pattern, vomiting, significant weight loss, and deep tenderness in the
 midline in epigastrium are the main presentations.
- Zollinger–Ellison syndrome: Caused by excessive secretion of gastrin by enter enteroendocrine cells, which in turn continuously stimulate parietal cells to secret HCl thus causing gastric and duodenal ulcers.

SMALL INTESTINE

- Diarrhea: Loose watery stools that occur more frequently due to infections. This may be fatal if extreme dehydration is not attended timely.
- Crohn's disease or regional enteritis is an idiopathic chronic ulcerative inflammatory bowel disease, characterized by transmural, noncaseating granulomatous inflammation, affecting most commonly the segment of terminal ileum and/or colon, though any part of the gastrointestinal tract may be involved.
- Celiac sprue is the most important cause of primary malabsorption occurring in temperate climates. The condition is characterized by significant loss of villi in the small intestine and thence diminished absorptive surface area. If the intestinal mucosa is exposed to profound irritation by toxic substance, the muscularis externa undergo intense, swift contractions of long duration called peristaltic rush. This leads to diarrhea.
- **Typhoid and tubercular ulcer:** The typhoid damages Peyer's patches causing longitudinal ulcer, tubercular lesions affect lymphatics causing strictures and circular ulcers.

COLON AND RECTUM

- **Ulcerative colitis** is an idiopathic form of acute and chroniculcero-inflammatory colitis affecting chiefly the mucosa and submucosa of the rectum and descending colon, though sometimes it may involve the entire length of the large bowel.
- Acute appendicitis: Acute inflammation of the appendix is the most common acute abdominal condition confronting the surgeon. The disease is seen more frequently in the West and in affluent societies which may be due to variation in diet—a diet with low bulk or cellulose and high protein intake more often causes appendicitis.
- Hemorrhoids or piles are the varicosities of the hemorrhoidal veins. They are called "internal piles" if dilatation is of superior hemorrhoidal plexus covered over by mucous membrane, and "external piles" if they involve inferior hemorrhoidal plexus covered over by the skin. They are common lesions in elderly and pregnant women. They commonly result from increased venous pressure.



EXAM-ORIENTED QUESTIONS

- 1. Describe the microscopic anatomy of esophagus, fundus of stomach, pylorus of stomach, duodenum, jejunum, ileum, large intestine, appendix.
- 2. Describe the layers of GIT.
- 3. Describe the changes in epithelium down the GIT.
- 4. Describe the ultrastructure of cells of stomach.
- 5. Compare and contrast histological features of parts of small intestine.
- 6. Compare and contrast histological features of small and large intestine.
- 7. Describe the factors responsible for increase in surface area of small intestine.



MULTIPLE CHOICE QUESTIONS

- 1. Toughest layer of esophagus is:
 - a. Mucosa
- b. Submucosa
- c. Muscularis externa
- d. Adventitia
- 2. Lining epithelium of esophagus is:
- a. Simple squamous epithelium
 - b. Transitional epithelium
 - c. Pseudostratified epithelium
 - d. Stratified squamous nonkeratinized epithelium
- 3. Mucus glands of esophagus are found in:
 - a. Lining epithelium
- b. Submucosa
- c. Muscularis externa
- d. Adventitia
- 4. Nerve plexus of muscularis externa is called as:
 - a. Meissner's plexus
- b. Auerbach's plexus
- c. Barrett's plexus
- d. Brachial plexus

- 5. Brunner's glands are found in the mucosa of:
 - a. Stomach
- b. Colon
- c. Duodenum
- d. Esophagus
- 6. Following cells are found in small intestine, except:
 - a. Stem cells
- b. Goblet cells
- c. Neck cells
- d. Paneth cells
- 7. Cells which give beaded cells to the mucosa of the stomach are:
 - a. Stem cells
- b. Chief cells
- c. Neck cells
- d. Parietal cells
- 8. Peyer's patches are characteristic feature of:
 - a. Stomach
- b. Colon
- c. Ileum
- d. Esophagus

Answers

2. d 4. b 7. d 1. c 3. b

Inderbir Singh's Textbook of Human Histology

Salient Features

- The content has been updated while preserving the legacy of the original book.
- The syllabus follows National Medical Commission (NMC) of India requirements, including competencies.
- Content is simplified to aid students in easy understanding and retention.
- Better resolution slides with relevant plates that are student friendly are given.
- A core highlight of this edition is the addition of easily reproducible hand-written diagrams of histology slides observed in practical classes, assisting with practical record writing and examinations.
- Identification points are provided with every slide.
- Applied aspects are included based on relevance.
- Extra information is clearly marked as "Added Information" for optional reference.
- Clinical case scenarios relevant to histology are included in each chapter.
- Review questions and updated MCQs are added.
- Online video lectures of histology of basic structures and different organ systems are included.

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Printed in India



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EMCA House, 23/23-B, Ansari Road,
Daryaganj, New Delhi - 110 002, INDIA
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