Stomach and Duodenum Anatomy

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Embryology

- **Stomach**
- Develops from foregut
- Tubular --> descends and elongates and rotates --> disproportionate elongation of the greater curvature
- **Duodenum**
- 1st and 2 nd part upto major duodenal papilla → foregut
- Distal 2nd part. 3rd and 4th part → midgut

Surgical Anatomy

- Parts of stomach
- stomach is fixed at the gastroesophageal (GE) junction an pylorus
- large midportion is mobile

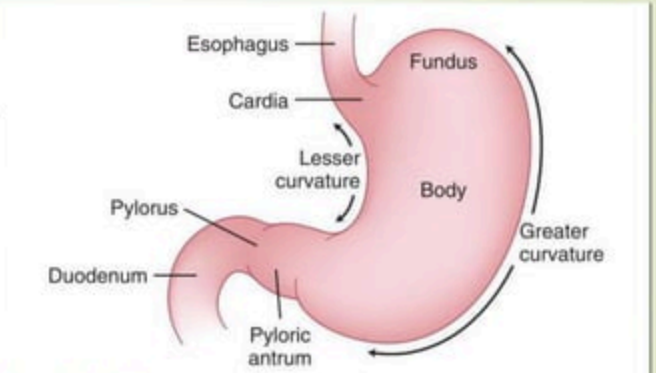
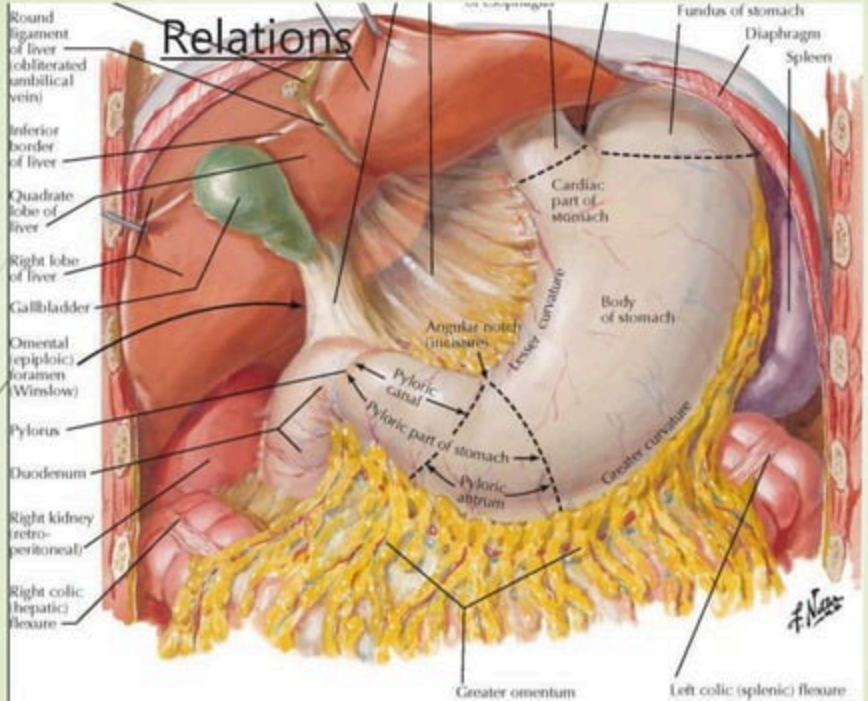
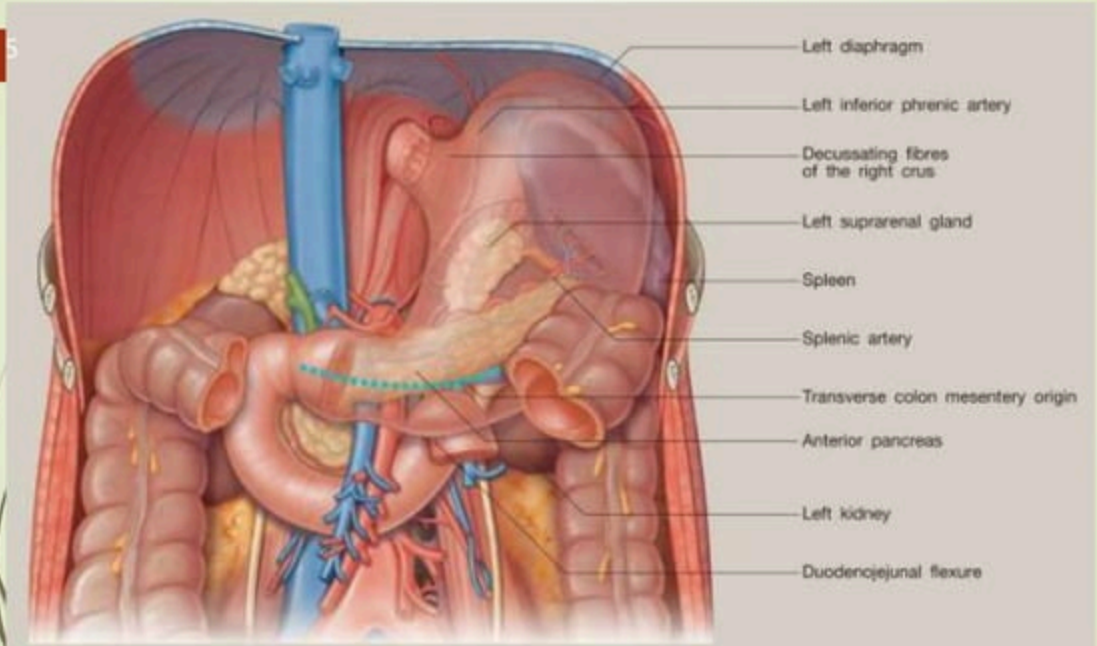
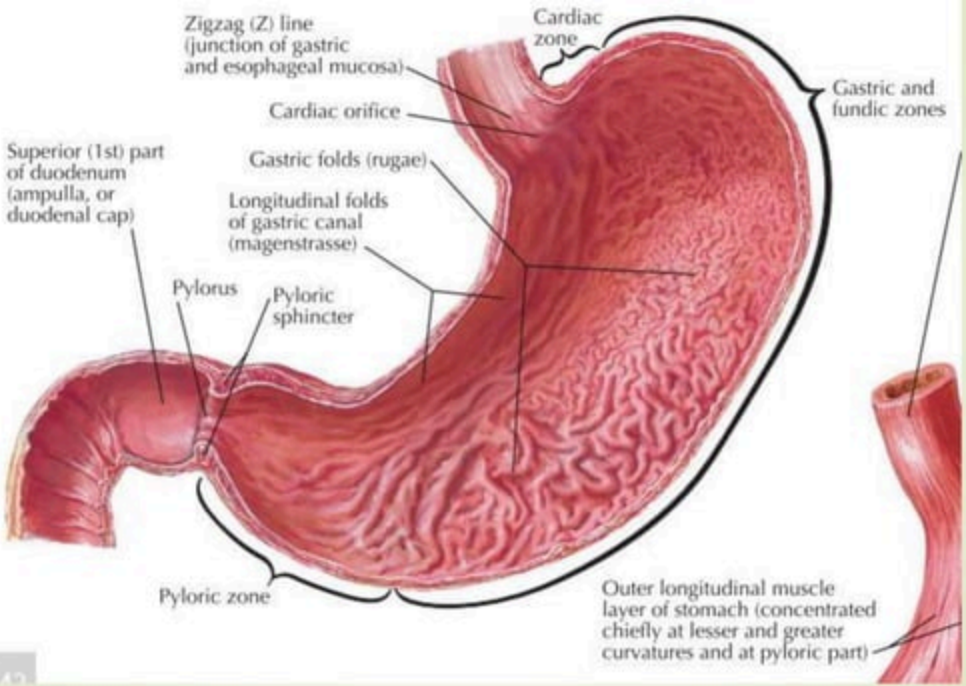


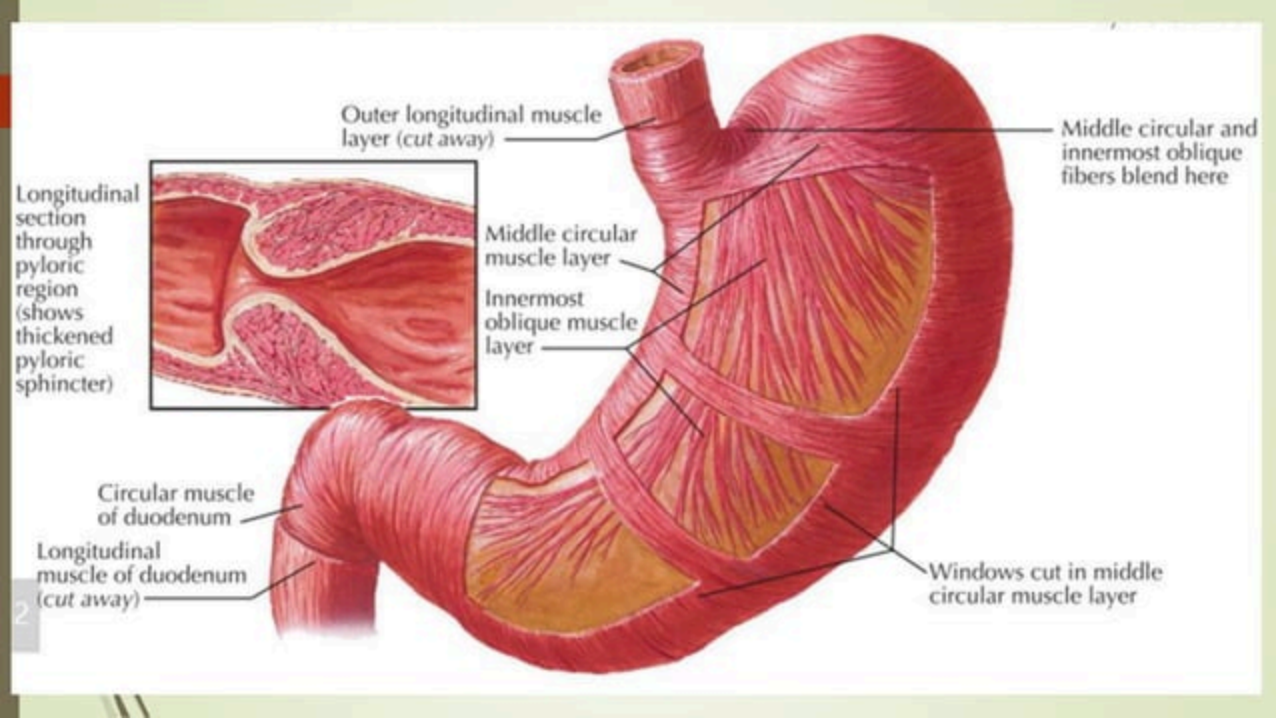
FIGURE 48-1 Divisions of the stomach. (From Yeo C, Dempsey DT, Klein AS, et al, editors: *Shackelford's surgery of the alimentary tract*, ed 6, Philadelphia, 2007, Saunders.)

Relations


Round ligament of liver (obliterated umbilical vein)
Inferior border of liver
Quadrate lobe of liver
Right lobe of liver
Gallbladder
Omental (epiploic) foramen (Winslow)
Pylorus
Duodenum
Right kidney (retro-peritoneal)
Right colic (hepatic) flexure
Fundus of stomach
Diaphragm
Spleen
Cardiac part of stomach
Lesser curvature
Body of stomach
Angular notch (incisure)
Pyloric canal
Pyloric part of stomach
Pyloric antrum
Greater curvature
Greater omentum
Left colic (splenic) flexure


Left diaphragm
Left inferior phrenic artery
Decussating fibres of the right crus
Left suprarenal gland
Spleen
Splenic artery
Transverse colon mesentery origin
Anterior pancreas
Left kidney
Duodenojejunal flexure


Zigzag (Z) line
(junction of gastric
and esophageal mucosa)
Cardiac
zone
Gastric and
fundic zones
Cardiac orifice
Superior (1st) part
of duodenum
(ampulla, or
duodenal cap)
Gastric folds (rugae)
Longitudinal folds
of gastric canal
(magenstrasse)
Pylorus
Pyloric
sphincter
Pyloric zone
Outer longitudinal muscle
layer of stomach (concentrated
chiefly at lesser and greater
curvatures and at pyloric part)


Outer longitudinal muscle layer (cut away)
Middle circular and innermost oblique fibers blend here
Longitudinal section through pyloric region (shows thickened pyloric sphincter)
Middle circular muscle layer
Innermost oblique muscle layer
Circular muscle of duodenum
Longitudinal muscle of duodenum (cut away)
Windows cut in middle circular muscle layer

Blood Supply

- Veins of the stomach parallel the arteries.
- The left gastric (coronary) and right gastric veins usually drain into the portal vein.
- The right gastroepiploic vein drains into the superior mesenteric vein, and the left gastroepiploic vein drains into the splenic vein.

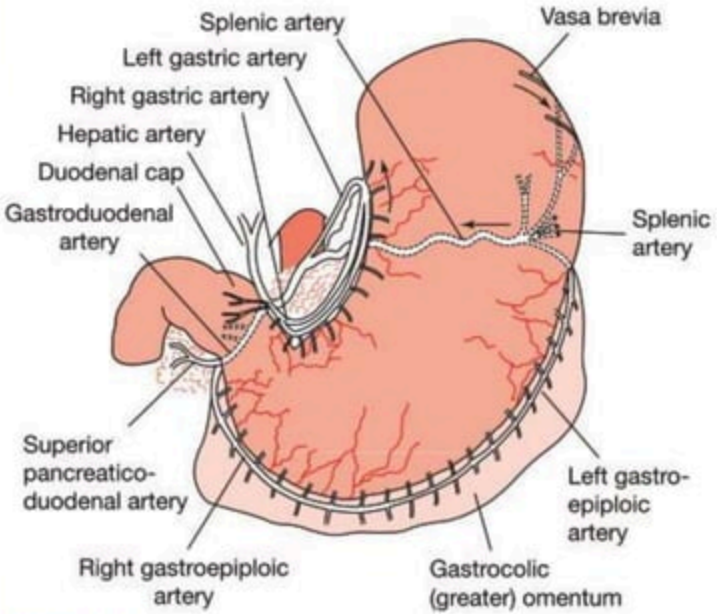
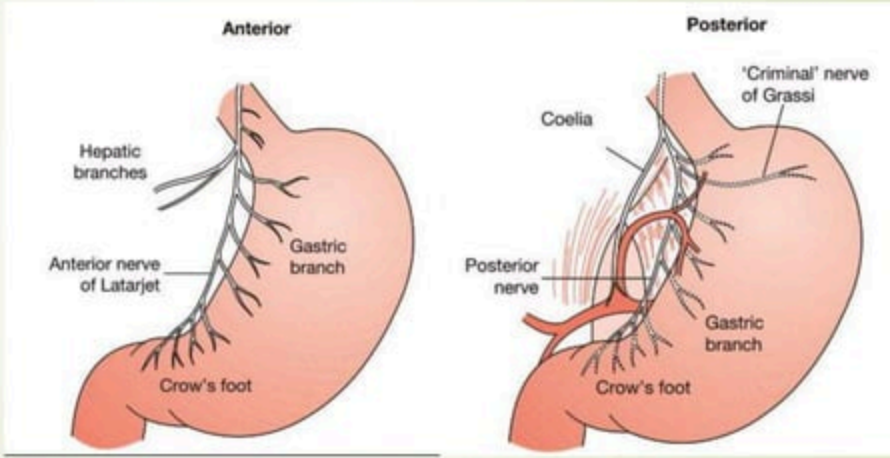


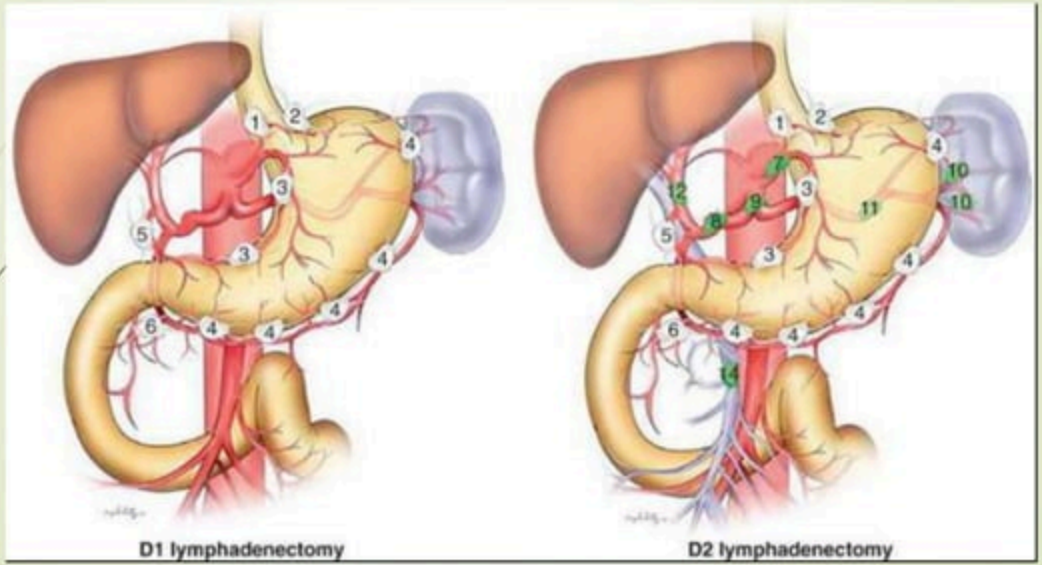
Figure 63.1 The arterial blood supply of the stomach.

Nerve Supply

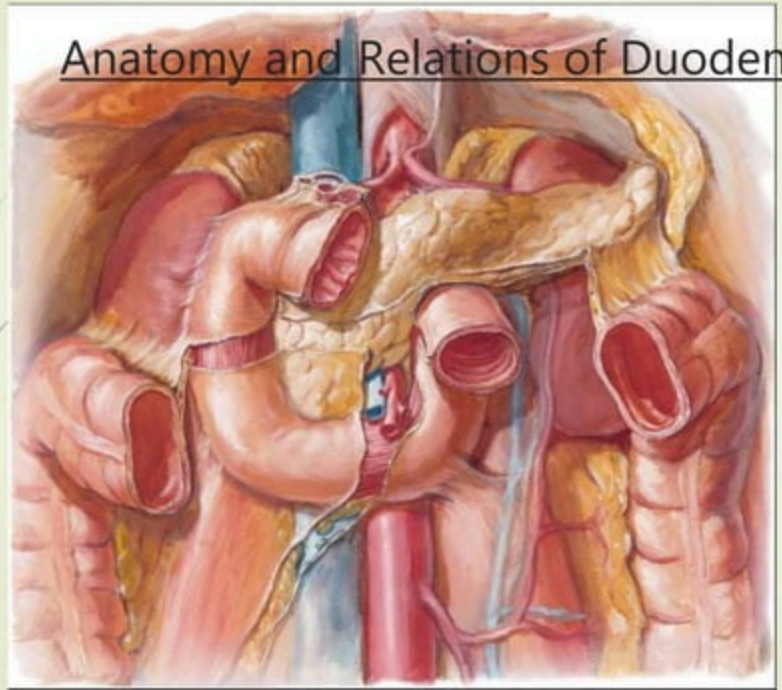
- intrinsic nerves --> two plexuses, the myenteric plexus of Auerbach and the submucosal plexus of Meissner.
- extrinsic supply --> vagus nerve Left/anterior and Right/posterior branch.

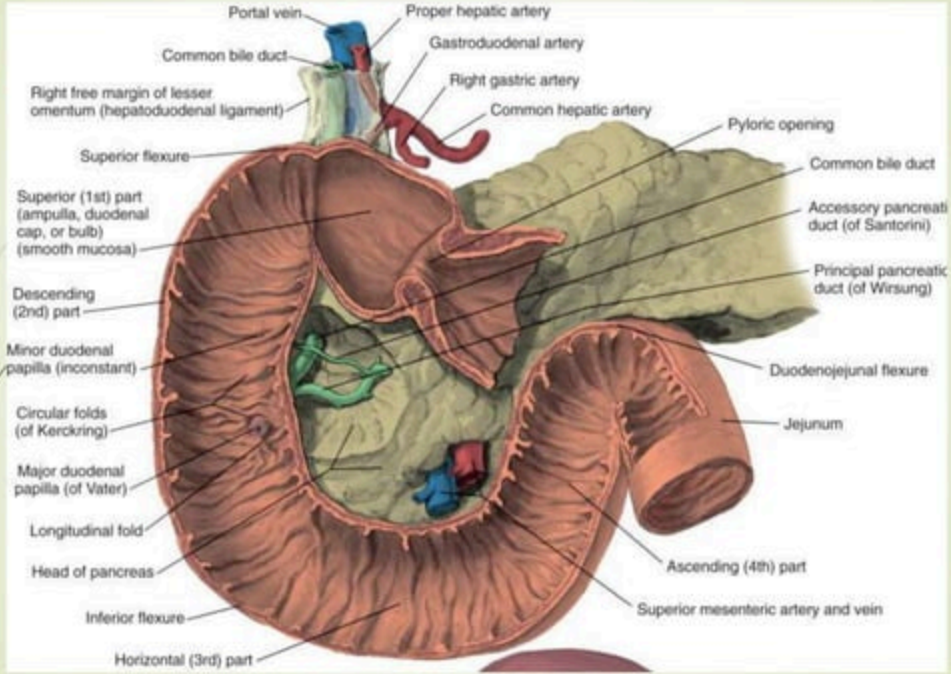


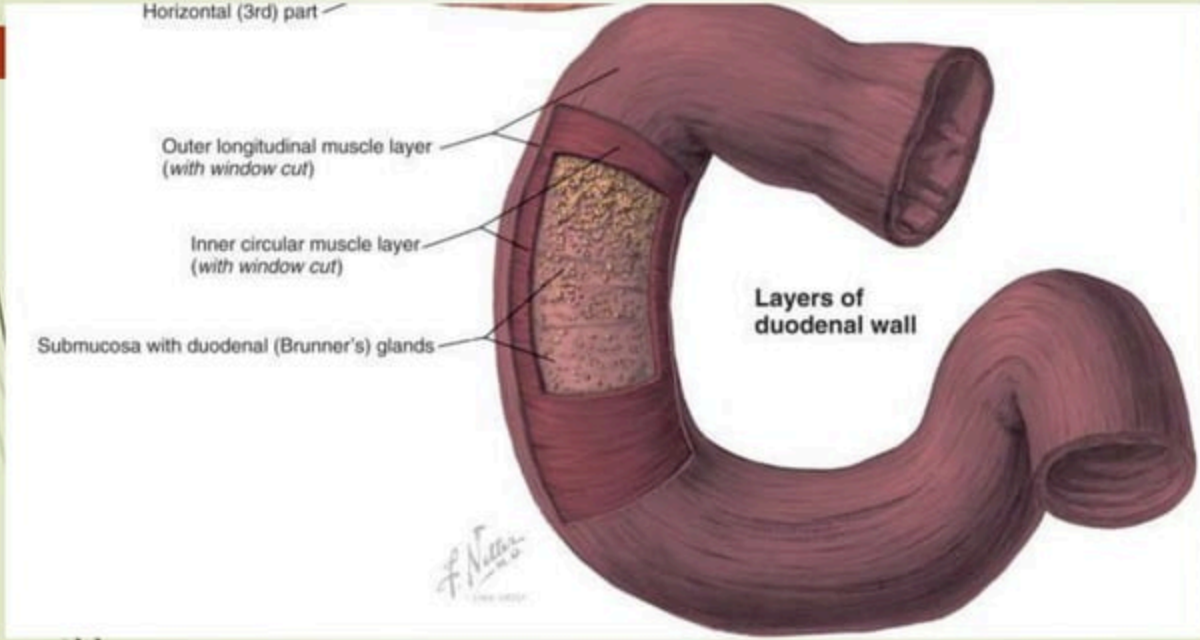
Lymphatic Drainage



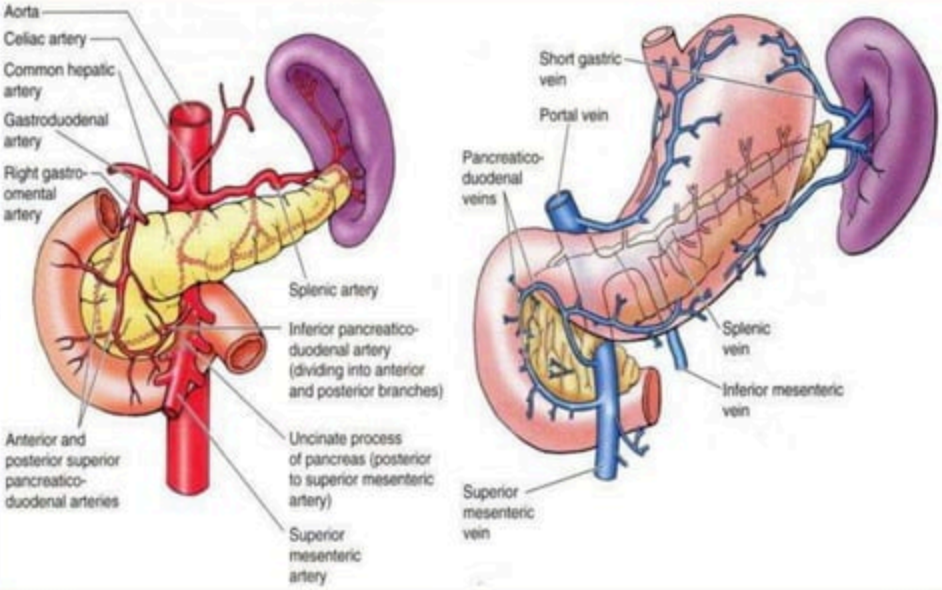
Anatomy and Relations of Duodenum




Portal vein
Proper hepatic artery
Common bile duct
Gastroduodenal artery
Right free margin of lesser omentum (hepatoduodenal ligament)
Right gastric artery
Common hepatic artery
Pyloric opening
Superior flexure
Common bile duct
Superior (1st) part (ampulla, duodenal cap, or bulb) (smooth mucosa)
Accessory pancreati duct (of Santorini)
Principal pancreatic duct (of Wirsung)
Descending (2nd) part
Minor duodenal papilla (inconstant)
Duodenojejunal flexure
Circular folds (of Kerckring)
Jejunum
Major duodenal papilla (of Vater)
Longitudinal fold
Head of pancreas
Ascending (4th) part
Superior mesenteric artery and vein
Inferior flexure
Horizontal (3rd) part


Horizontal (3rd) part
Outer longitudinal muscle layer
(with window cut)
Inner circular muscle layer
(with window cut)
Submucosa with duodenal (Brunner's) glands
Layers of
duodenal wall

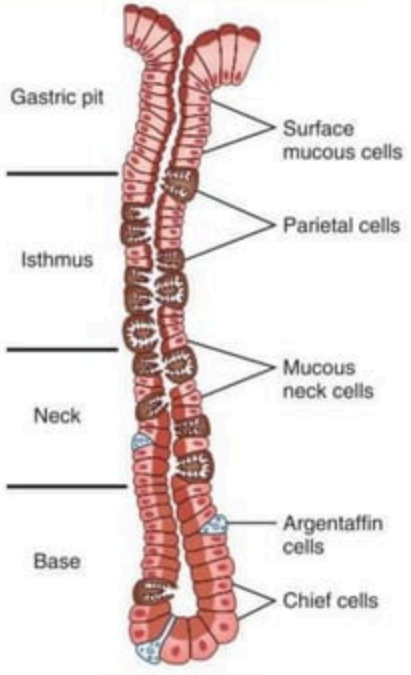
Arterial supply and venous drainage of the duodenum



PHYSIOLOGY OF THE STOMACH AND DUODENUM

Gastric Microscopic Anatomy

CELL TYPE	LOCATION	FUNCTION
Parietal	Body	Secretion of acid and intrinsic factor
Mucus	Body, antrum	Mucus
Chief	Body	Pepsin
Surface epithelial	Diffuse	Mucus, bicarbonate, prostaglandins (?)
Enterochromaffin-like	Body	Histamine
G	Antrum	Gastrin
D	Body, antrum	Somatostatin
Gastric mucosal interneurons	Body, antrum	Gastrin-releasing peptide
Enteric neurons	Diffuse	Calcitonin gene–related peptide, others
Endocrine	Body	Ghrelin



Gastric gland

- Duodenum
- The duodenum is lined by a **mucus-secreting columnar epithelium**.
- Brunner glands
- Brunner glands are branched, tubuloalveolar glands with mucus-secreting acini located in the **duodenal**
- Brunner glands produce a bicarbonate-rich fluid, also rich in epidermal growth factor (EGF). The bicarbonate neutralises the acidic gastric juice entering the duodenum. EGF inhibits HCl production of parietal cells and stimulates mitotic activity in the epithelial cells.
- Endocrine cells in the duodenum produce cholecystokinin and secretin.

PHYSIOLOGY OF THE STOMACH AND DUODENUM

- The stomach mechanically breaks up ingested food and, together with the actions of acid and pepsin, forms chyme that passes into the duodenum.
- In contrast with the acidic environment of the stomach, the environment of the duodenum is alkaline, due to the secretion of bicarbonate ions from both the pancreas and the duodenum. This neutralises the acid chyme and adjusts the luminal osmolarity to approximately that of plasma.
- Endocrine cells in the duodenum produce cholecystokinin, which stimulates the pancreas to produce trypsin and the gall bladder to contract. Secretin is also produced by the endocrine cells of the duodenum. This hormone inhibits gastric acid secretion and promotes production of bicarbonate by the pancreas.

Gastric acid secretion

- Hydrogen ions are produced by the parietal cell by the proton pump.
- Histamine produced by ECL cells acts on H2 receptor in parietal cell in a paracrine fashion.
- proton pump - final common pathway – hydrogen ion secretion.
- The ECL cell produces histamine in response to a number of stimuli that include the vagus nerve and gastrin.
- Gastrin is released by the G cells in response to the presence of the food in the stomach.
- The production of gastrin is inhibited by acid, creating a negative feedback loop.

- three phases of gastric secretion
- The **cephalic phase** is mediated by **vagal activity**, secondary to sensory arousal as first demonstrated by Pavlov.
- The **gastric phase** is a response to food within the stomach, which is mediated principally, but not exclusively, by **gastrin.**
- In the **intestinal phase**, the presence of chyme in the duodenum and small bowel inhibits gastric emptying, and the acidification of the duodenum leads to the production of **secretin**, which inhibits gastric acid secretion, along with numerous other peptides originating from the gut.
- **Somatostatin** produced by D cells in stomach in response to a number of factors including acidification, acts probably on the G cell, the ECL cell and the parietal itself to inhibit the production of acid.

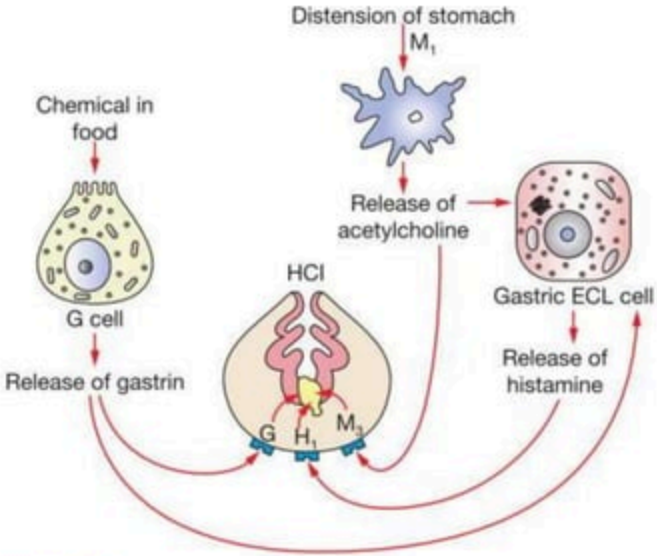


Figure 63.4 The parietal cell in relation to the mechanism of gastric acid secretion. ECL, enterochromaffin-like; G, gastrin receptor; H, histamine receptor; HCl, hydrochloric acid; M, muscarinic receptor.

Gastric mucus and the gastric mucosal barrier

- essential to the integrity of the gastric mucosa
- viscid layer of mucopolysaccharides produced by the mucus-producing cells of the stomach and the pyloric glands
- buffering capacity is enhanced by the presence of bicarbonate ions within the mucus
- bile, non-steroidal anti-inflammatory drugs (NSAIDs), alcohol, trauma and shock → lead to breakdown.
- The stomach is the most sensitive to ischaemia following a hypovolaemic insult and also the slowest to recover → stress ulceration

Gastroduodenal motor activity

- In the fasted state, and after food has cleared, in the small bowel there is a period of quiescence lasting in the region of 40 minutes (phase I).
- There follows a series of waves of electrical and motor activity, also lasting for about 40 minutes, propagated from the fundus of the stomach in a caudal direction at a rate of about three per minute (phase II). These pass as far the pylorus, but not beyond. Duodenal slow waves are generated in the duodenum at a rate of about 10 per minute, which carry down the small bowel.
- The amplitude of these contractions increases to a maximum in phase III, which lasts for about 10 minutes. This 90-minute cycle of activity is then repeated. From the duodenum, the MMC moves distally at 5–10 cm/ min, reaching the terminal ileum after 1.5 hours.

- Following a meal, the stomach exhibits receptive relaxation, which lasts for a few seconds. Following this, adaptive relaxation occurs, which allows the proximal stomach to act as a reservoir.
- Most of the peristaltic activity is found in the distal stomach (the antral mill) and the proximal stomach demonstrates only tonic activity.
- The pylorus, which is most commonly open, contracts with the peristaltic wave and allows only a few millilitres of chyme through at a time. The antral contraction against the closed sphincter is important in the milling activity of the stomach.
- Although the duodenum is capable of generating 10 waves per minute, after a meal it only contracts after an antral wave reaches the pylorus.
- The coordination of the motility of the antrum, pylorus and duodenum means that only small quantities of food reach the small bowel at a time.
- This control of gastric emptying can be abolished after gastric surgery leading to significant symptoms. Motility is influenced by numerous factors, including mechanical stimulation and neuronal and endocrine influences