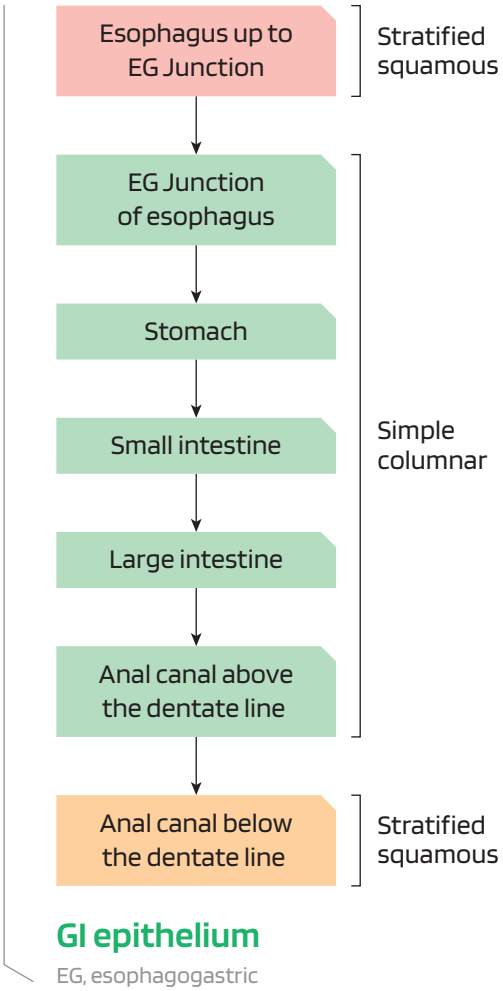
Anatomy

Esophagus	- Upper 1/3: striated muscle - Middle 1/3: mixed muscles - Lower 1/3: smooth muscles
Stomach	Gastric pits lead into gastric glands which contains: - mucous neck cells - parietal cells - chief cells - neuroendocrine cells (G cells)
Duodenum	Duodenal (Bruner) glands which secrete alkaline juice
Jejunum	Circular folds (plicae circulares) are more pronounced
Ileum	Payer's patches (aggregation of lymphoid tissues)
Colon	- No villi (as opposed to small intestine) - Many crypts of Lieberkühn
Anal canal	Proximal (above dentate line) & distal (below dentate line) have distinct neurovascular supply

Both small & large intestine have crypts of Lieberkühn which are invaginations of epithelium.

Specific histology features of GI tract



GI epithelium

EG, esophagogastric

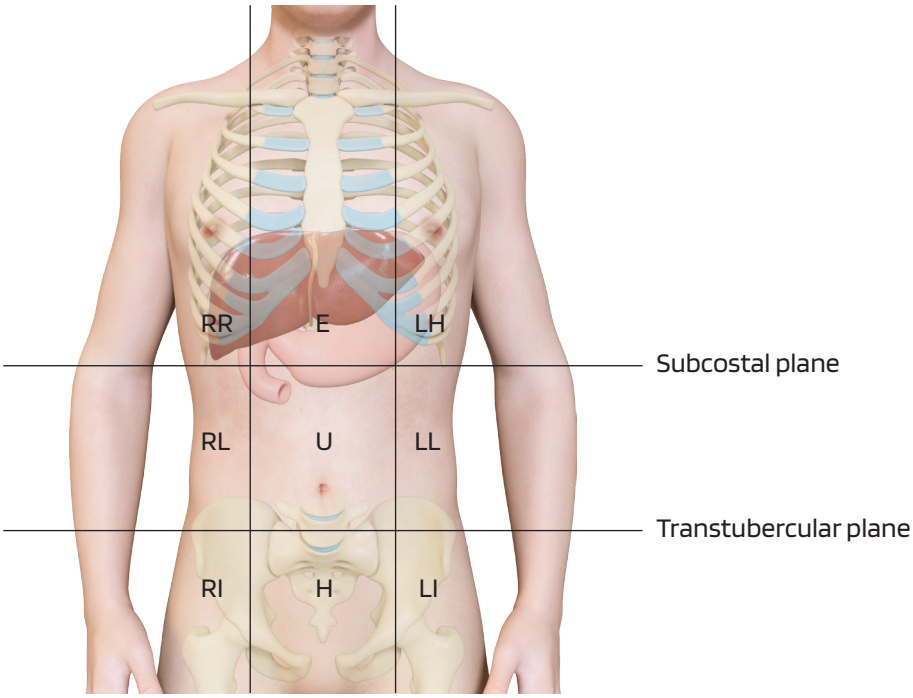
Goblet cells	Mucin production
Enterocytes	Absorption
Paneth cells	Contain defensins, lysozyme & phospholipase A2 (innate immunity)
Neuroendocrine	GI movement and endocrine function
M cells	Transepithelial transport of microorganisms into Peyer's patches (innate immunity)

Intestinal cells

Abdomen areas

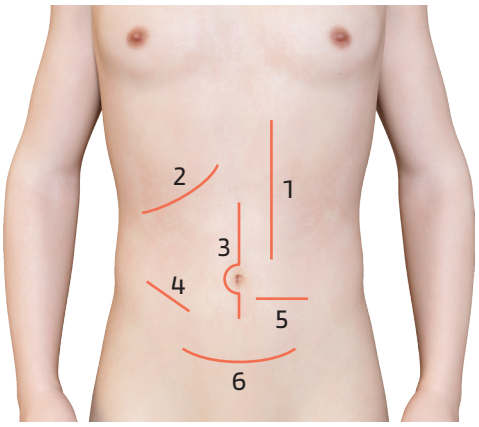
The abdomen is divided into **four quadrants** (RUQ, RLQ, LLQ, LUQ) or **nine regions.** The four quadrants are formed by two imaginary lines passing through the umbilicus horizontally and vertically. The horizontal line is perpendicular to the sagittal midline place.

The nine region system is made by **two midclavicular & 2 horizontal lines (subcostal & transtubercular).** Transtubercular line passes through the iliac crest tubercles (around the L5 level).
In the first row, two hypochondriac regions are on each side of the epigastric area. The second row has two lumbar regions on each side of the umbilical region. In the third row, the hypogastric region is between the two inguinal regions.
The **transpyloric plane** (at the level of L1) is essential for imaging. It contains many essential organs, including the pylorus, the first part of the duodenum, fundus of the gallbladder, the origin of the superior mesenteric artery, portal vein, splenic vein, and part of the pancreas.



Abdomen areas

Abdominal incisions

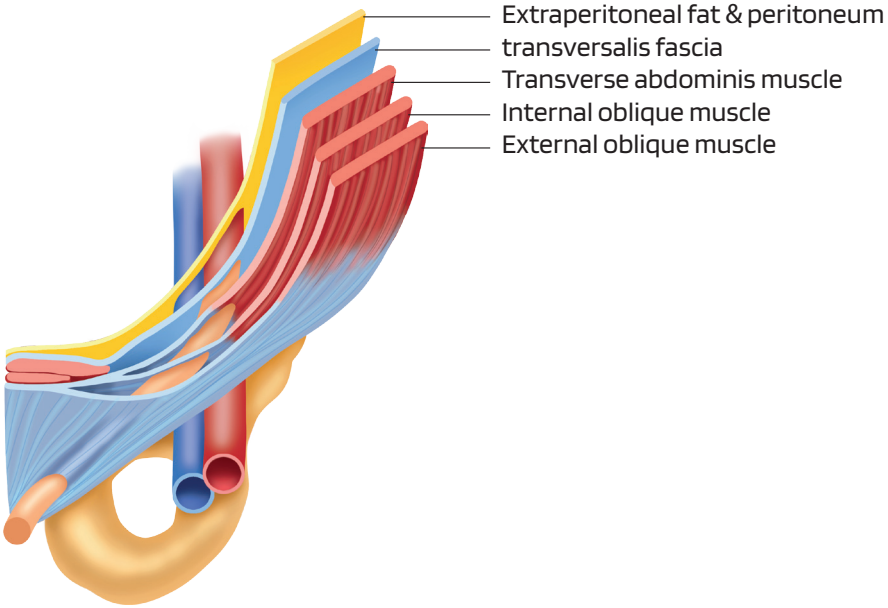


1. Paramedian
2. Subcostal
3. Median
4. McBurney
5. Transverse
6. Pfannenstiel

Abdominal incisions

Abdominal wall layers

The abdominal wall consists of the skin, fascia (2 layers), muscle (3 layers), transversalis fascia, extraperitoneal fat, and peritoneum.



Abdominal wall layers

Fascia

The **external layer (Camper's fascia)** contains fat. The **internal layer (Scarpa's fascia)** is dense and has collagen. Camper's fascia is absent in the perineum. In contrast, Scarpa's fascia continues into the perineum and takes multiple names. It is called **Colles' fascia** when it surrounds the roots of the penis and clitoris. It is called **superficial penile (or clitoral) fascia** when it surrounds the shaft of the penis. It is called **Dartos fascia** in the scrotum.

Embedded in the adipose tissue of Camper's fascia are the superficial epigastric veins, which drain the anterior abdominal wall. These cutaneous veins drain into the femoral and paraumbilical veins. Scarpa fascia is the deep part of superficial fascia. It is continuous with perineal (Colles'), penile (Buck fascia), and scrotal (Dartos) fascia.

Muscular layer

The muscular layer consists of 3 muscles: external oblique, internal oblique, and transverse abdominis.

Aponeurosis of external oblique muscle

The aponeurosis of the external oblique muscle folds posteriorly, and its distal part forms the **inguinal ligament.** The **lacunar ligament** is the most inferior portion of the inguinal ligament, which is attached to the pectineal ligament. The **pectineal ligament** is the strong tendon-like band formed by fibers of the lacunar ligament.

The external oblique aponeurosis joins the aponeurosis of the internal oblique and transverse abdominis muscles to form the rectus sheath.

The Internal oblique muscle continues in the inguinal canal and becomes the cremaster muscle that covers the testes.

Arcuate line

The arcuate line is between the upper 3/4 and lower 1/4 of the abdominal wall. Below the arcuate line, the lower abdominal wall is weaker and is more prone to hernias. Mostly because the linea alba is not developed distally, and the posterior rectus sheath is not supported distally by the aponeurosis of the abdominal muscles.

Inguinal canal

The inguinal canal has the **floor** (inguinal ligament), a **roof** (transverse abdominis muscle), an **anterior wall** and a **posterior wall.** The transversalis fascia makes the posterior wall. The **deep inguinal ring** is in transversalis fascia where inferior epigastric vessels are medial to this ring. The anterior wall is formed by aponeurosis of external oblique muscles. It contains the **superficial inguinal ring.** The epigastric vessels are lateral to this ring.

Outpocketing of transversalis fascia gives rise to the internal spermatic fascia.

The external spermatic fascia originates from the external oblique muscle.

The internal oblique muscle forms the cremaster muscle, and the fascia of internal oblique muscle makes the cremasteric fascia.

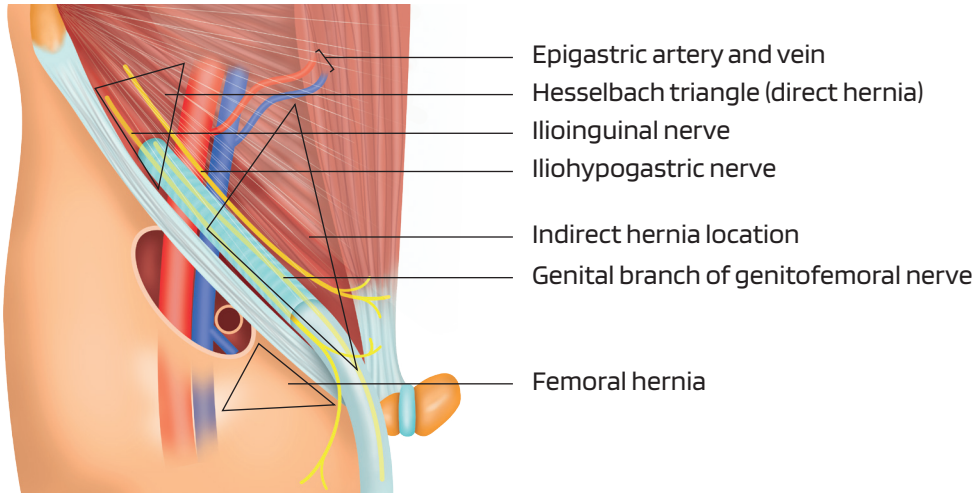
The inguinal ligament makes the floor of the inguinal canal, and the roof is formed by muscle fibers of transversus abdominis and internal oblique muscle

Spermatic cord

The spermatic cord passes through the inguinal canal. It contains ductus deferens & its artery, testicular artery and nerves, pampiniform plexus of the testicular vein, sympathetic nerves, genital branch of the genitofemoral nerve, cremaster muscle, lymphatic vessels, and the remnant of processus vaginalis.

Inguinal hernia

A direct hernia develops directly through the abdominal wall. This area of the abdominal wall is called the **Hesselbach triangle.** This triangle is made medially by the rectus sheath, laterally by the epigastric vessels and inferiorly by the inguinal ligament.

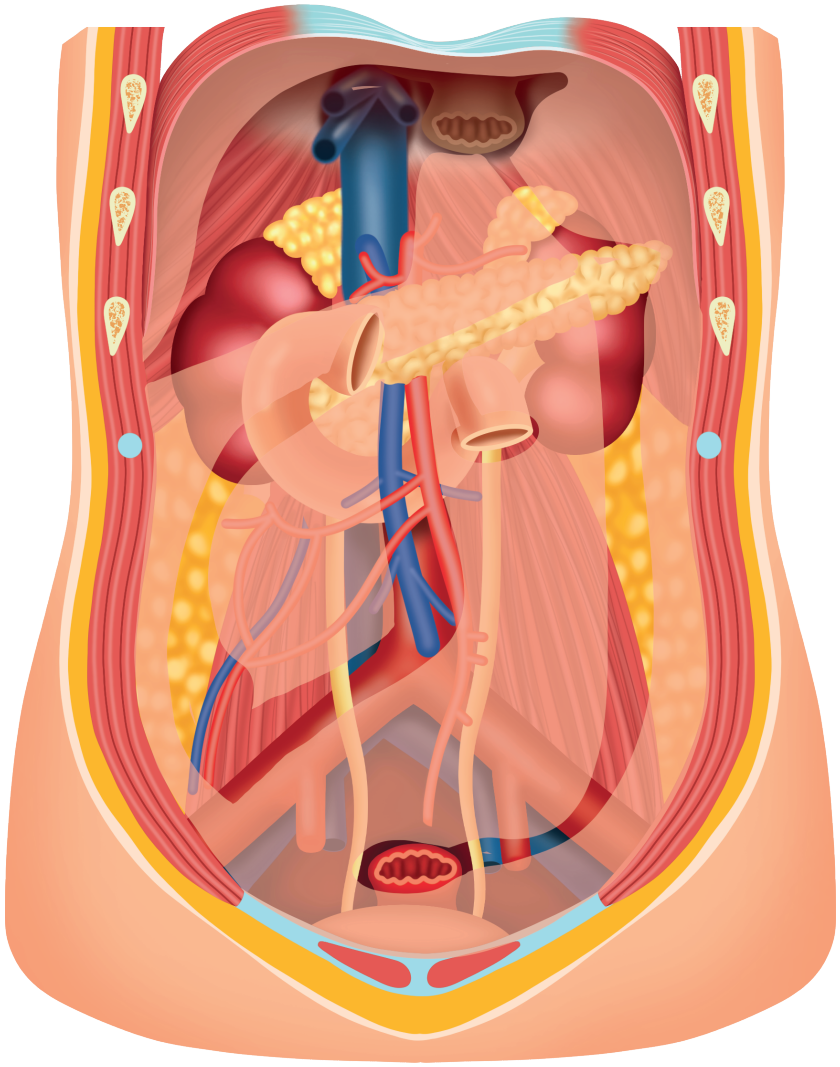


Inguinal area triangles

An indirect inguinal hernia develops lateral to inferior epigastric artery and vein and enters the deep inguinal ring. Then it passes through the inguinal canal.

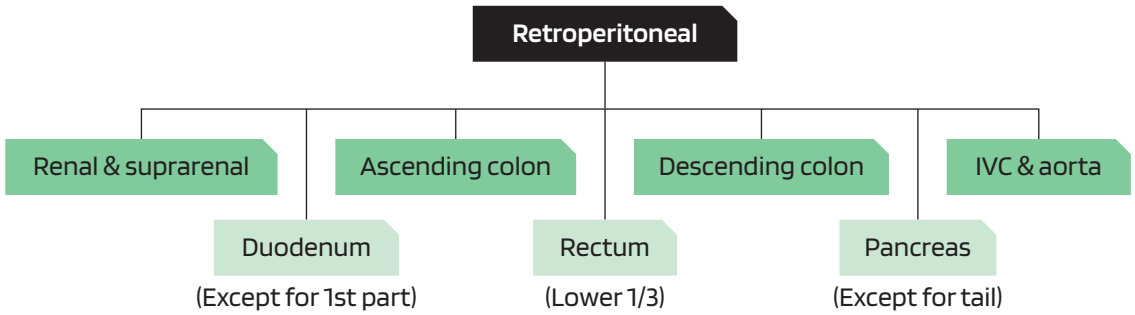
Peritoneum

The peritoneum derives from the dorsal or ventral mesentery of the embryo. A mesentery never suspends primary retroperitoneal organs. Examples are the kidney or aorta. **Secondary retroperitoneal** refers to structures that are partially covered by the peritoneum. Ascending and descending colons used to be covered by peritoneum completely (suspended by a mesentery). However, the posterior part of the peritoneum has disappeared.



Primary and secondary retroperitoneal organs

Inflammation of the parietal peritoneum causes sharp pain, guarding, and rebound tenderness. However, inflammation of the visceral peritoneum causes dull pain.



Primary and secondary retroperitoneal organs

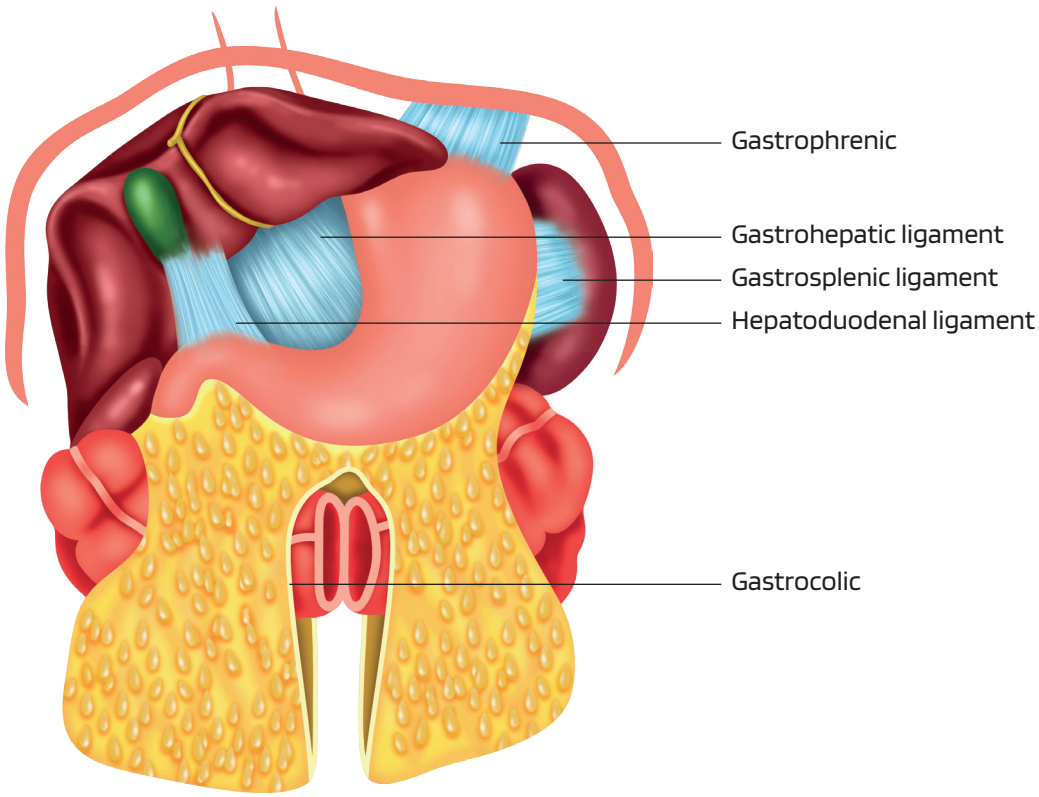
Peritoneum has two main coverings called the lesser and the greater omentum.

Lesser omentum

The lesser omentum is between the liver and the stomach. Its lower part forms the **hepatoduodenal** ligament, and its upper part forms the **gastrohepatic** ligament. Important vessels, including the portal vein, run between the layers of these ligaments.

Greater omentum

It starts from the greater curvature of the stomach, folds on itself and covers the small intestine and finally attaches to the transverse colon and posterior abdominal wall.



Lesser and greater omentum

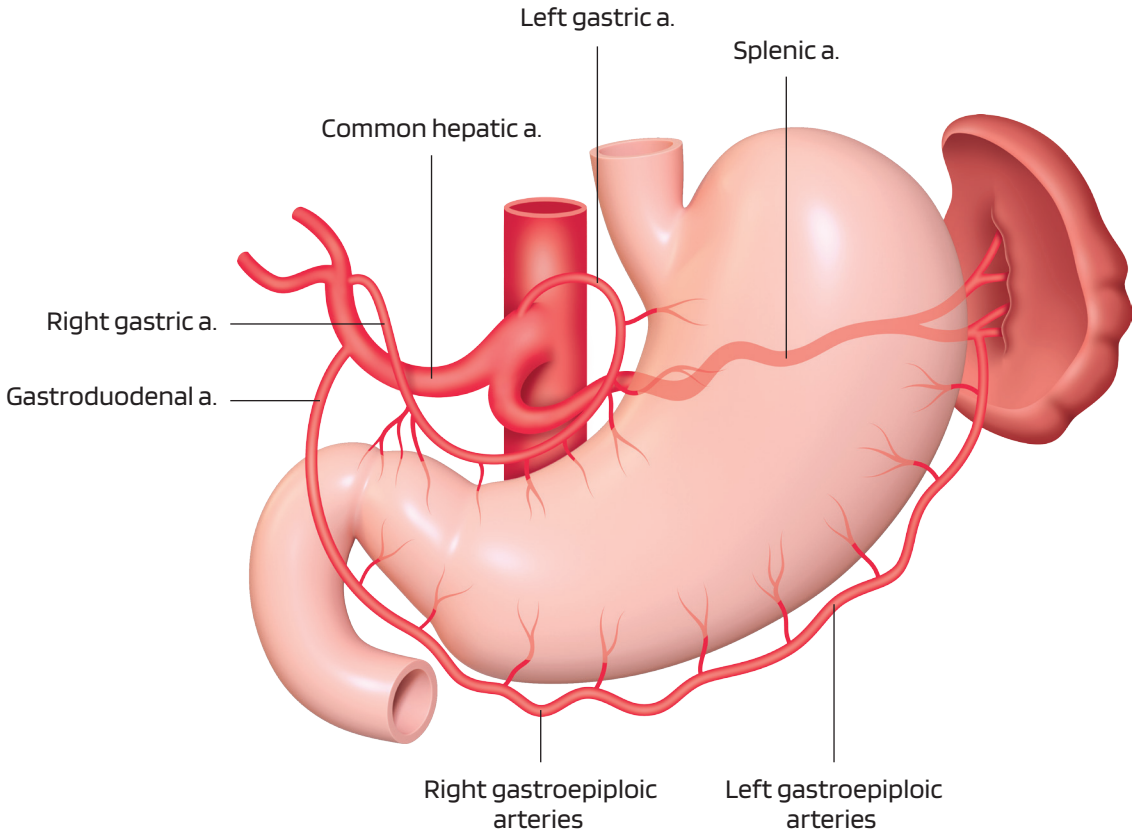
Arterial supply of the abdomen

Celiac artery

The Right gastric artery branches off the hepatic artery proper before hepatic artery division into the right and left hepatic arteries.
The Right and left gastric arteries travel along the lesser curvature and anastomose.
The gastroduodenal artery has three branches, including the left gastroepiploic, anterior, and superior pancreaticoduodenal arteries. Along the greater curvature of the stomach, the right gastroepiploic artery anastomoses with the left gastroepiploic artery (a branch of the splenic artery).

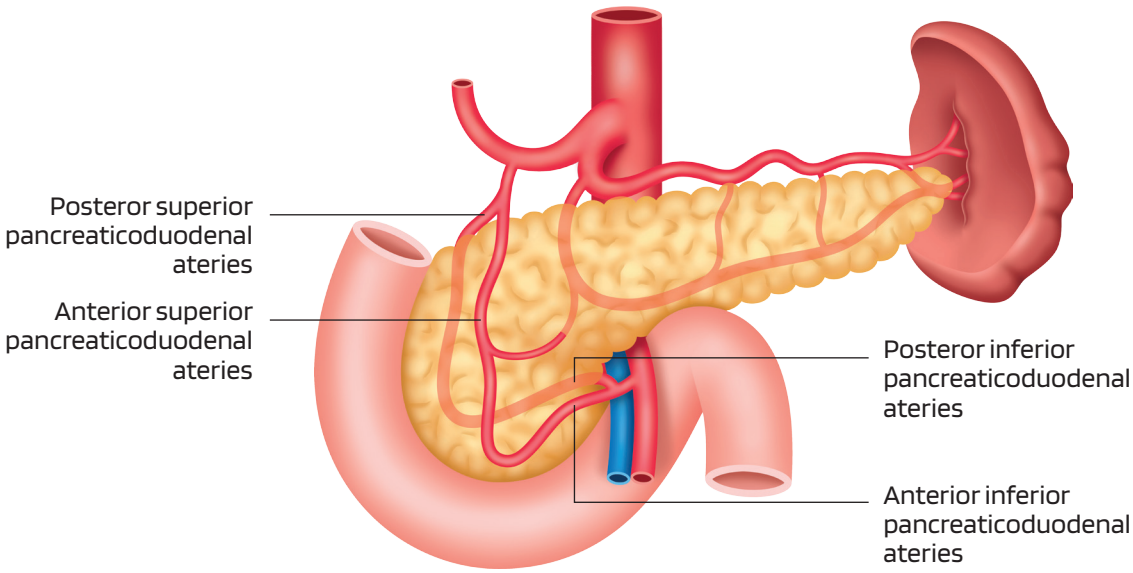
The anterior and posterior superior pancreaticoduodenal arteries anastomose with their inferior counterparts (branches of the superior mesenteric artery). This is an important anastomosis between the celiac and SMA.

The splenic artery has short gastric artery branches that supply the fundus ; these branches have no anastomoses.



The celiac artery

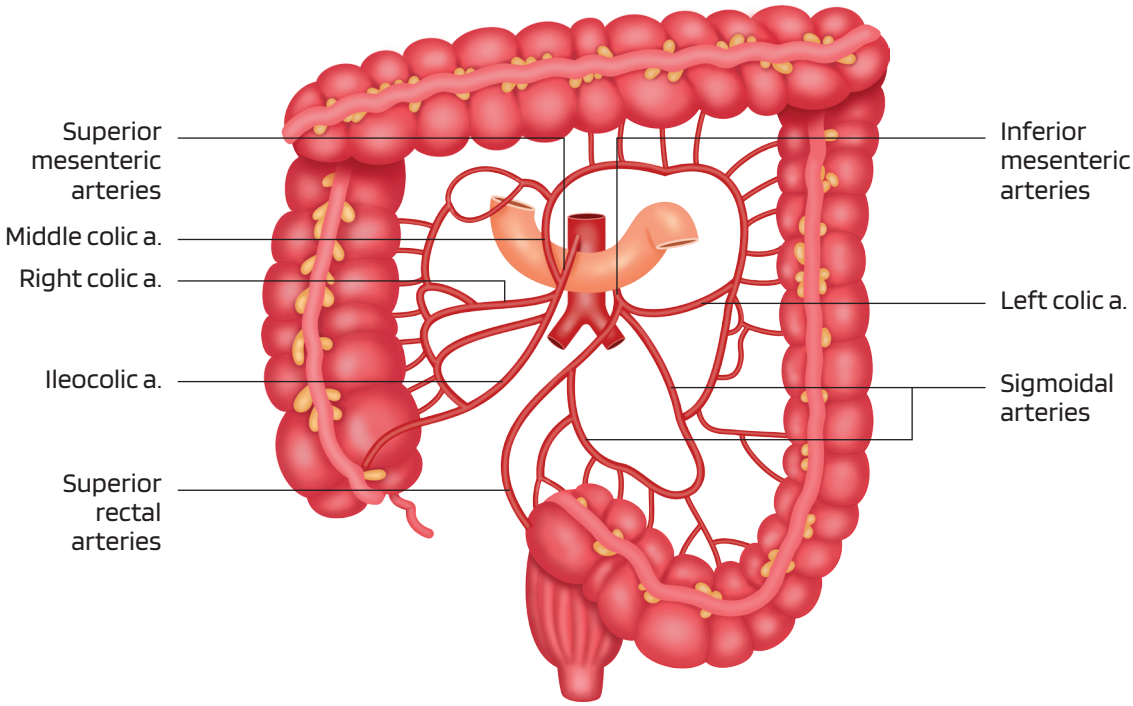
The 3 branches are are left gastric a., common hepatic a., & splenic a. The common hepatic artery branches off into the hepatic artery proper and gastroduodenal artery



Anastomosis between the celiac and superior mesenteric arteries

Superior mesenteric artery

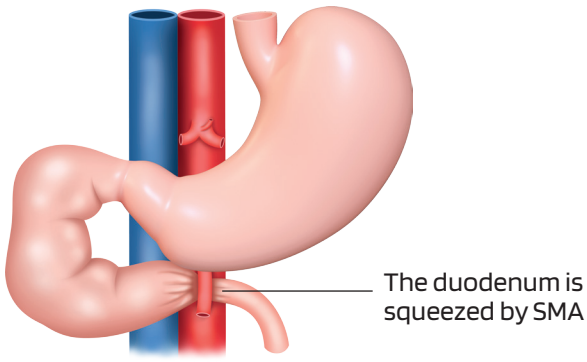
The anterior and posterior inferior pancreaticoduodenal arteries anastomose with their superior counterparts. The **middle colic, right colic, and ileocolic arteries** are other important branches.
Vasa recta to jejunum are long while vasa recta to ileum are short.



Superior & inferior mesenteric arteries

Superior mesenteric artery syndrome

Normally, there is fat between the horizontal part of the duodenum and the superior mesentery artery, however, if a patient loses a lot of weight quickly, the cushion effect of the fat is lost, and it is possible to have a **duodenal obstruction** (SMA squeezes the duodenum).



Superior mesenteric artery syndrome

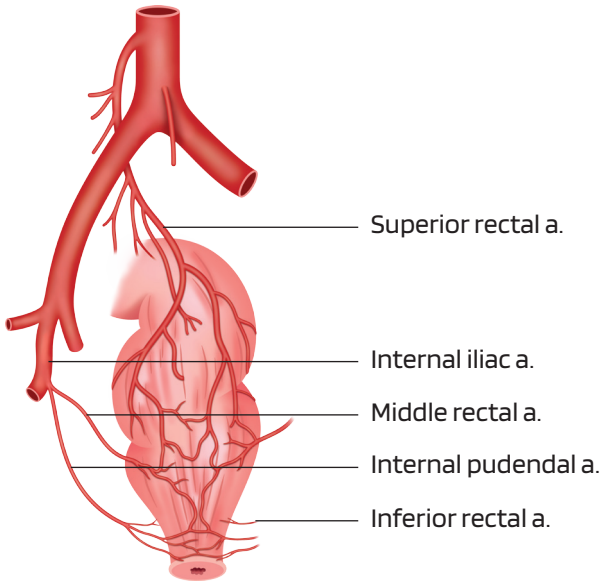
Inferior mesenteric artery

The main branches include **left colic, sigmoidal** & **superior rectal arteries.** Near the splenic flexure, the left colic artery anastomoses with the middle colic artery.

The splenic flexure area is the watershed area that is sensitive to ischemia.

Arterial supply of the rectum

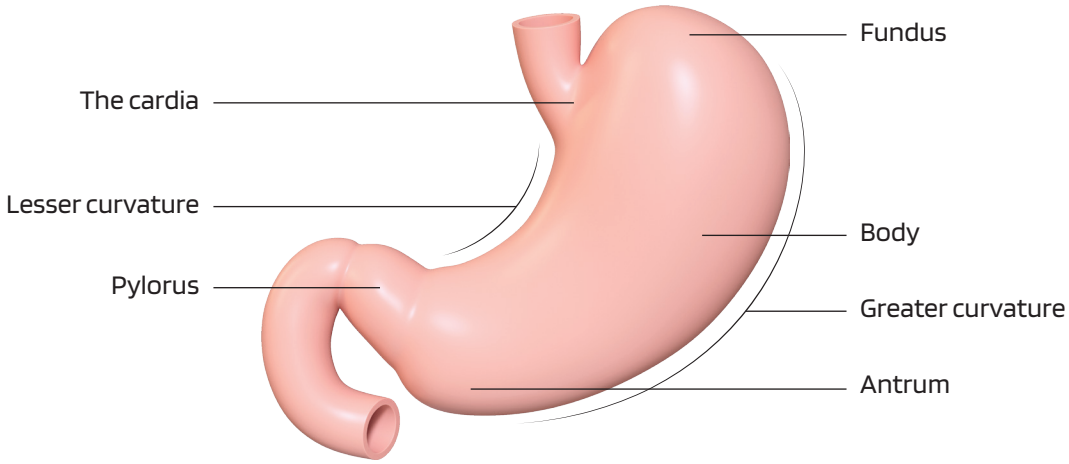
Superior rectal artery (a branch of inferior mesenteric a.), **middle rectal** artery (a branch of internal iliac a.), and **inferior rectal** artery (a branch of internal pudendal a.) supply the rectum.



Arterial supply of the rectum

Stomach anatomy

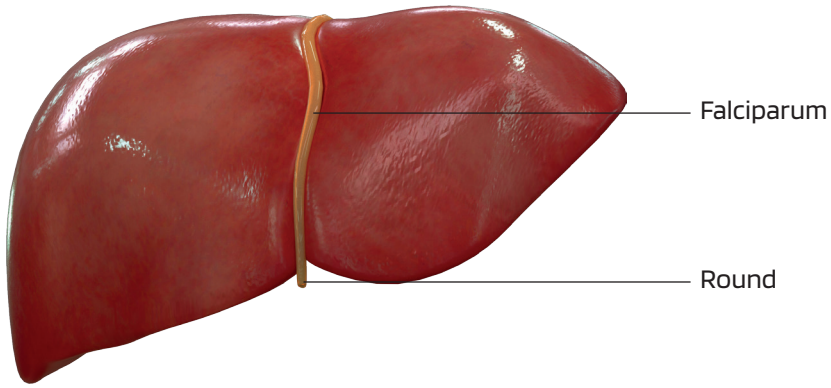
Cardia is the most proximal part of the stomach. The distal end of the stomach is the **pylorus.** Both the distal and proximal ends act as sphincters. These two areas are relatively fixed while the rest of the stomach is mobile. The lesser curvature is on the right, and the greater is on the left. The most superior part is the **fundus**, which is above the horizontal plane of the GE junction. The cardia is the GE junction area. The body contains most of the stomach and is between the fundus and the **angular incisura.** The **antrum** starts where the greater curvature turns right and is about 30% of the stomach. The antrum is located between the body and the pylorus.



Anatomy of the stomach

Liver anatomy

This largest and segmented organ is covered by a fibrous sheath (**Glisson capsule**) and held in place by multiple ligaments. The round ligament (the fate of umbilical vein) attaches the falciparum ligament, which separates the right and left lobes. They anchor the liver to the abdominal wall.
The **hepatoduodenal ligament** contains the portal vein, hepatic artery, and common bile duct. It also has the epiploic foramen that allows access to the lesser sac and clamping these vessels (**Pingle maneuver**).

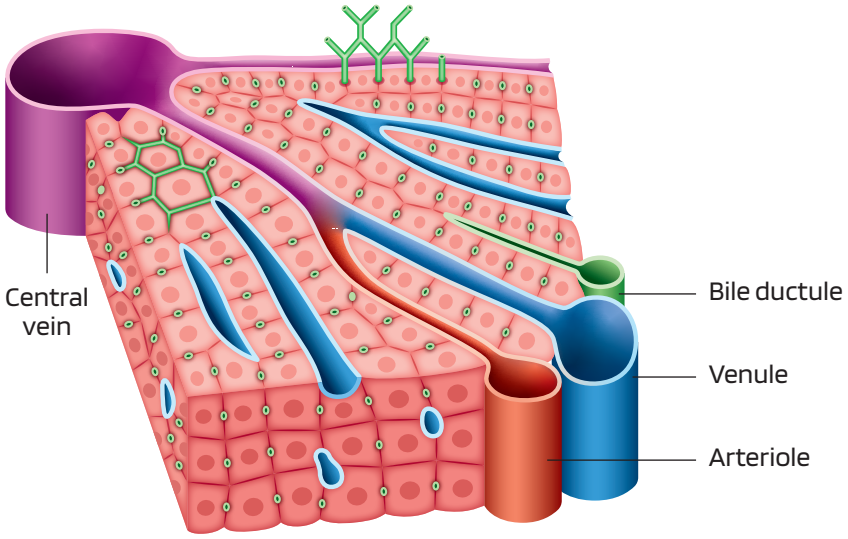


The liver

Note the falciparum ligament and the round ligament

Liver histology

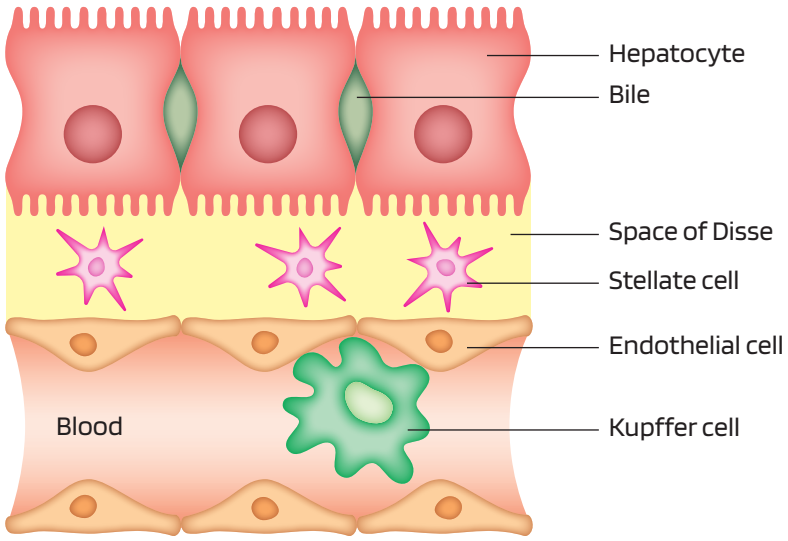
Lobules are the functional units, and each has a **central vein** and many sheets of hepatocytes surrounding the vein. The **portal triads** are around each lobule. The triads have an arteriole, a venule, and a bile ductule. Both arterioles and venules form sinusoids. The arterial and venous blood mixes here, and they enter the central vein ultimately.



Section of a hepatic lobule

Note the central vein, and the portal triad with an arteriole, a venule and a bile ductule

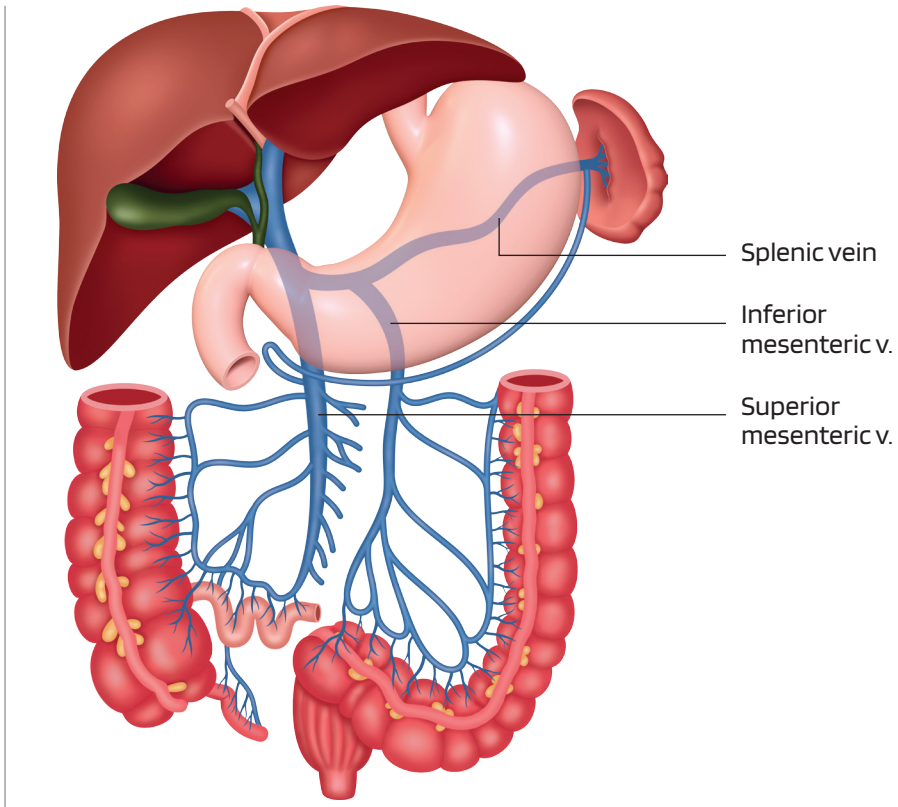
Sinusoids are fenestrated vessels that allow the hepatocytes to be in close contact with the plasma. The **space of Disse** or the perisinusoidal space contains plasma.
Kupffer cells are attached to the endothelial cells. Space of Disse is between hepatocytes and endothelial cells and contains **stellate cells**, which are myoepithelial cells. These cells **store vitamin A and, when activated, causes fibrosis.** They are important in cirrhosis pathophysiology.



Hepatocytes, Kupffer and stellate cells

The portal vein

The confluence of superior mesenteric and splenic veins forms the portal vein. The inferior mesenteric vein joins the splenic vein. The portal vein supplies 75% of blood supply (50% of O2 supply) to the liver.



Portal vein

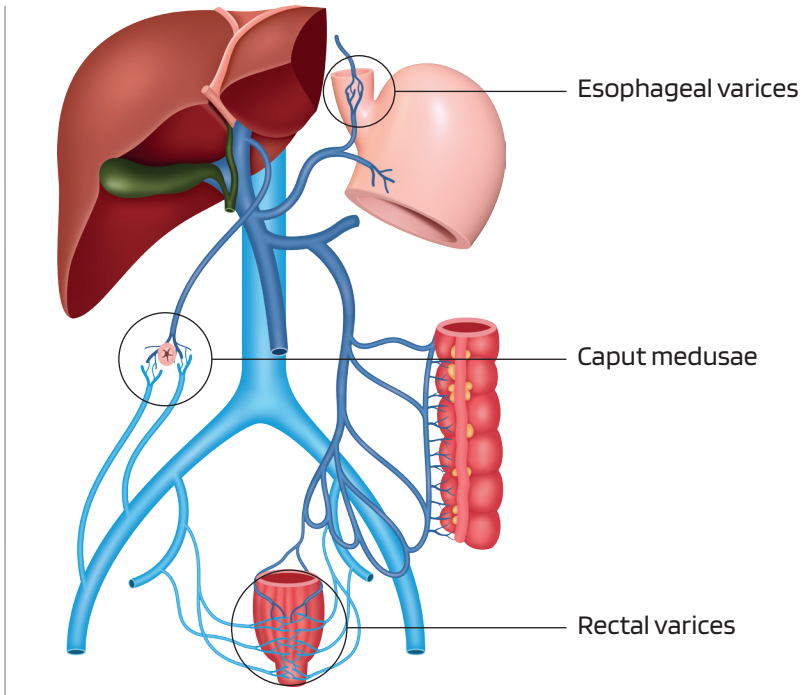
Portosystemic shunts

The connections between the portal and systemic venous system have important clinical applications. In portal hypertension, these anastomoses can cause varices and bleeding.

Bleeding esophageal varices are a common cause of death in cirrhotic patients.

Clinical picture	Portal	Caval
Esophageal varices	Left gastric vein	Azygos vein
Caput medusae	Paraumbilical veins	Superficial epigastric vein
Rectal varices	Superior rectal vein	Middle and inferior rectal veins

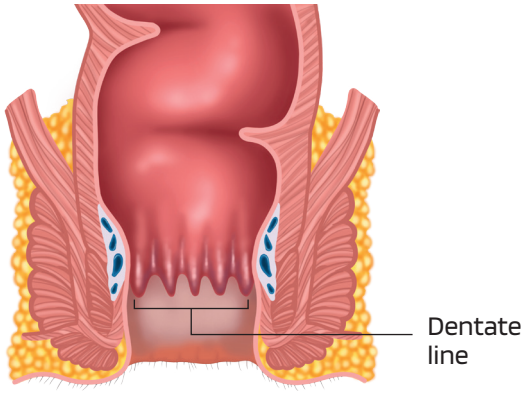
Clinically important portocaval anastomoses



Portocaval anastomoses

Anal canal anatomy

The **dentate** line separates the proximal and distal parts of the anal canal. The dentate line is between the endodermal and ectodermal origins.



Anal canal

Above the dentate line	Below the dentate line
Visceral innervation	Somatic innervation
Superior rectal artery (from inferior mesenteric a.)	Inferior rectal artery (from internal pudendal a.)
Superior rectal vein (drains into portal system)	Inferior rectal vein (drain into IVC ultimately)
Internal iliac nodes	Superficial inguinal nodes
Site of internal hemorrhoids	Site of external hemorrhoids

The anal canal neurovascular supply