

Digestive System

University of Jordan
Faculty of Medicine
Batch of 2013-2019

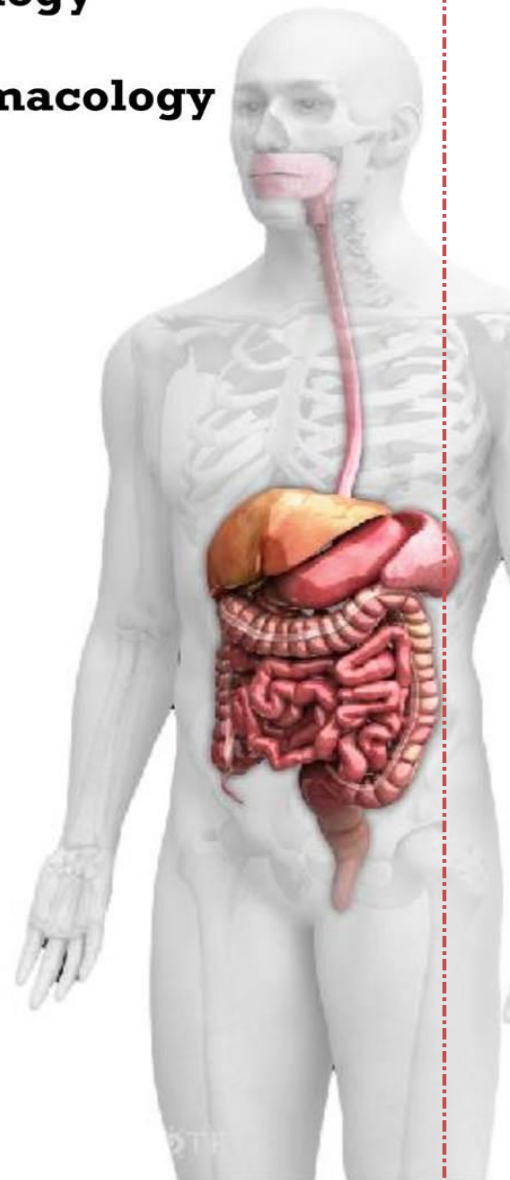


Slide Sheet Handout Other

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GI System
Anatomy, Lecture #7

Dr. "Mohammad Hisham Al-muhtasib"

April 5, 2015



Gross anatomy of the small intestines

Note: this sheet will include all the information written in the slides and not said by the doctor. Those information will start with a "*" .Any extra information mentioned in sec 2 recording is written in this sheet .Good luck

As we know the small intestines length is about 10 m (note that it's written 10 m in the slides but the dr. said it's 6 m and we ask him and he said that the slides are wrong and it's 6 m. However, wiki says: The average length of the small intestine in an adult human male is 6.9 m (22 ft 8 in), and 7.1 m (23 ft 4 in) in an adult female. It can vary greatly, from as short as 4.6 m (15 ft) to as long as 9.8 m (32 ft). but we must stick to what the dr. says). And it is divided into 3 major parts:

- 1- Duodenum
- 2- Jejunum
- 3- Ileum

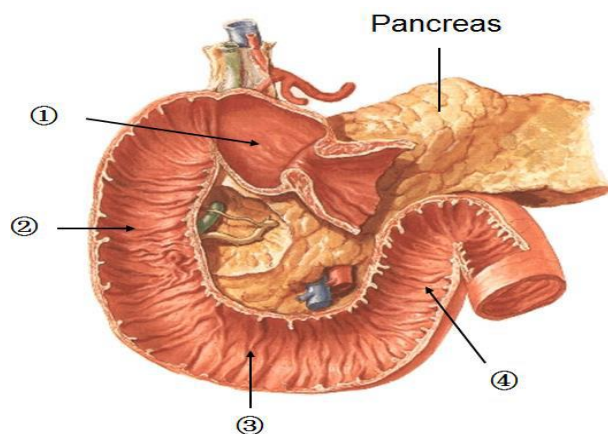
Each one of them will be discussed in this lecture

Duodenum

The major difference between the duodenum and jejunum and ileum is that the duodenum is Retroperitoneal (except first and last inch which are intraperitoneal), while the jejunum and ileum are intraperitoneal (they have mesentery)

General characteristics of the duodenum

- 1- It's a C-shaped hollow tube , it's length is about 10 inches (25 cm) it's divided into 4 parts for descriptive purposes : first part after the pyloric sphincter , 4th part before the jejunum
- 2- It's concave in shape and it's concavity is directed to the right and backwards

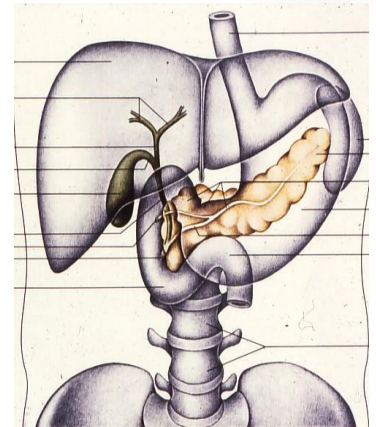


- 3- Head of the pancreas is presented in the concavity of the duodenum , * and the duodenum curves around the head of pancreas to the left and backwards
- 4- It receives the opening of the common bile duct and pancreatic duct where they both join, form the hepatopancreatic duct by their joining and open in the ampulla of vater which is a bulge structure located in the major duodenal papilla found in medial wall of the 2nd part of the duodenum (sometimes, there's also a minor duodenal papilla 1 inch above the major one to receive the opening of the accessory pancreatic duct) the flow of digestive juice (from gallbladder and pancreas) through the ampulla of vater is controlled by sphincter of oddi.
- 5- It's a retroperitoneal organ except the first inch which is covered by lesser omentum at its upper boarder and greater omentum at its lower boarder and lesser sac behind so it's considered intraperitoneal .In Addition to the first inch, the last inch of the duodenum is also intraperitoneal because it is covered by the ligament of treitz which marks the end of the duodenum and the beginning of the jejunum .
- 6- It completes the digestion of fat since it receives the common bile duct and pancreatic duct. Also it has a role in absorption of nutritive material.
- 7- The duodenum is surgically important for the treatment of stones in the common bile duct where they use the gastroscope which enters through the oral cavity to the duodenum then through the major duodenal papillae until they reach the common bile duct then remove the stone by retrograde mechanism toward the duodenal lumen and then it will go out with stool .This is a cheaper , faster and less invasive technique than open surgery which was used before. This technique is called **ERCP (Endoscopic Retrograde Cholangiopancreatography)**

Note: obstruction of the common bile duct by stones cause jaundice of the sclera of eye and the skin.

Site of the duodenum

*the duodenum is situated in the epigastric and umbilical region
 -the first part starts at the level of L1 and the second part descend till the level of L3 and the 4th part continue as Jejunum after the ligament of treitz .



Parts of the Duodenum and their relations (questions in the exam mostly come from here especially the relations)

First part of the duodenum

-it's 2 inches long , starts from the Pyloduodenal junction and ends at the neck of gallbladder at the level of transpyloric line so it's directed Upwards and backwards at the level of L1

-the first part is divided to:

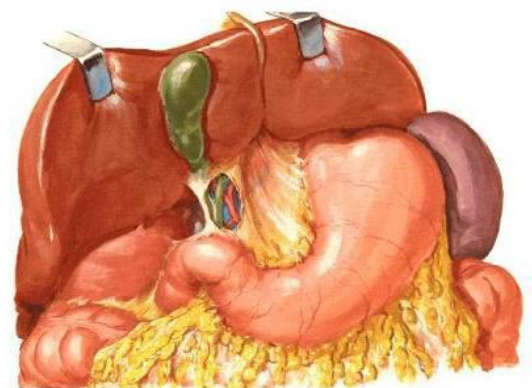
- 1- First inch which is intraperitoneal and it's the most common site of peptic ulcer.
- 2- 2nd inch which is retroperitoneal

Relations of the first part:

Anteriorly: the quadrate lobe of the liver and the gallbladder

Superiorly: epiploic foramen and the free edge of lesser omentum.

Liver in Situ



Posteriorly:

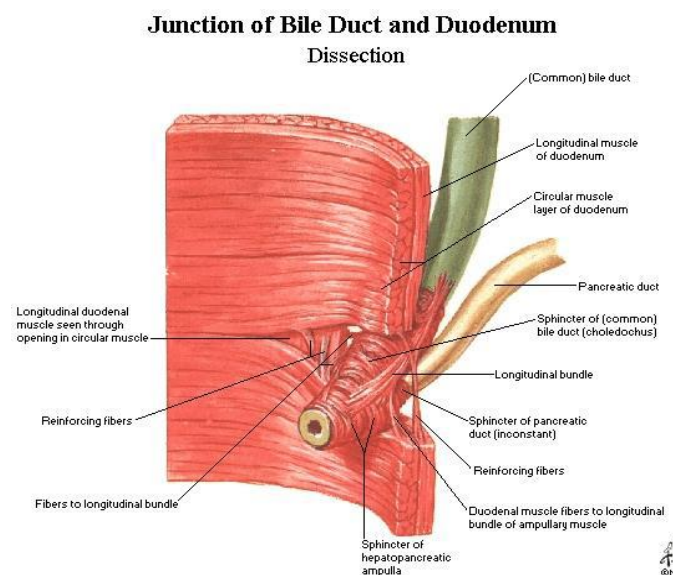
- 1- Gastroduodenal artery which is a branch from the hepatic artery and runs with the common bile duct, and it's very important in case of peptic ulcer because if a perforation occurred in the posterior wall of 1st part of duodenum, bleeding will happen from this artery. It gives the right gastroepiploic branch in greater omentum and pancreaticoduodenal branch for the pancreas and upper half of duodenum.
- 2- The bile duct
- 3- Portal vein: then it formed *behind the neck of pancreas* by the joining of splenic vein (which runs posterior to the body) and superior mesenteric vein and ascend posterior to the 1st part.
- 4- Inferior vena cava → more posterior
- 5- Lesser sac (most posterior) → deep to the lesser omentum thus deep to the duodenum

Inferiorly: the head of pancreas

2nd part of the duodenum

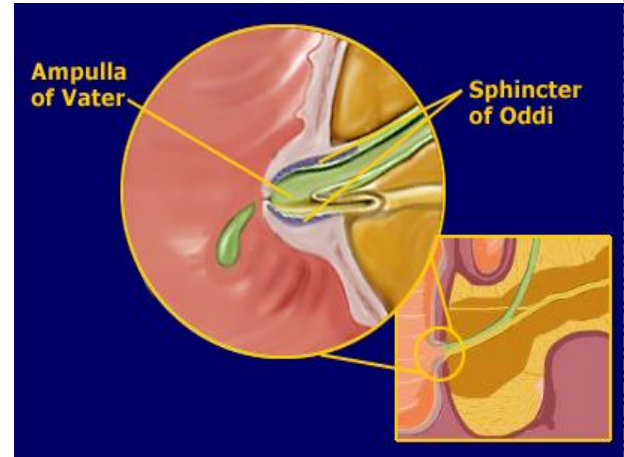
It is 3 inches long, runs downward and vertical in direction, it starts from the neck of the gallbladder passing in front of the hilum of right kidney and right ureter till reaching the level of L3.

-It is important because it receives the common bile duct and main pancreatic duct where they open into ampulla of Vater which is located in the major duodenal papilla on medial wall of the 2nd part of duodenum.



*Accessory pancreatic duct (if presented) will open in the minor duodenal papilla which is superior to the major duodenal papilla

-There is a sphincter made of thickening of smooth muscles in the ampulla of Vater called sphincter of oddi, it controls the flow of digestive juice toward the duodenum. It is contracted by sympathetic stimulation and relaxed by parasympathetic stimulation and Cholecystokinin. During ERCP technique for the treatment of bile duct stones, they cut through the sphincter of oddi in order to reach the stone and then the sphincter will heal on its own (and smooth muscles return back to normal) without any complications.



Note: sometimes there is variations in the ducts for example sometimes the common bile duct and pancreatic duct join before ampulla of Vater and they form common hepatopancreatic duct. Sometimes they don't join at all and each one open separately in the duodenum and has its own sphincter.

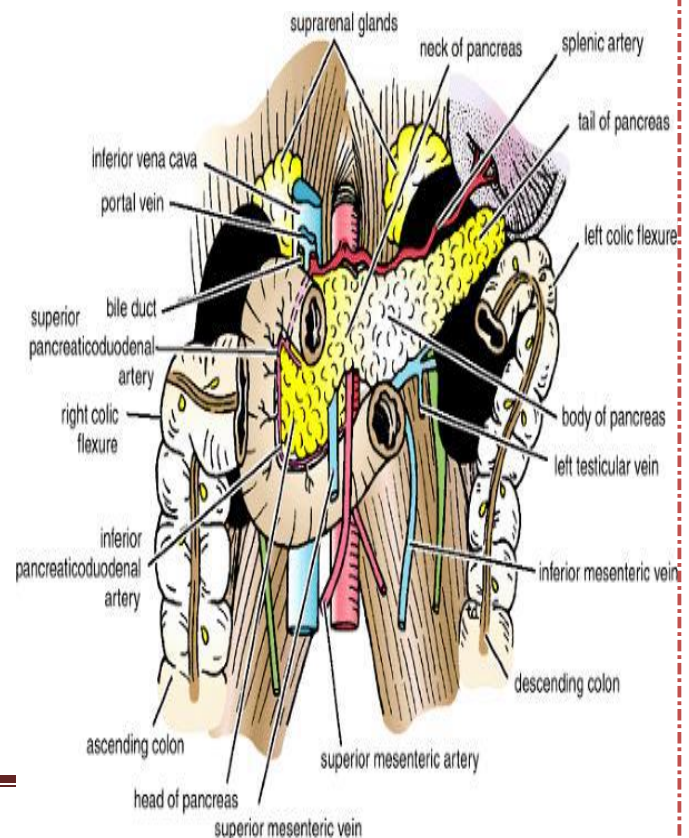
Relations of the 2nd part

Anteriorly

- 1- The fundus of the gallbladder
- 2- Right lobe of the liver
- 3- Transverse colon & mesocolon
- 4- Coils of small intestines

Posteriorly (important): Hilum of right kidney and right ureter

Medially: head of pancreas, common bile and pancreatic ducts



Laterally:

- 1- Right colic flexure
- 2- Ascending colon
- 3- Right lobe of the liver

3rd part of the duodenum

It's 4 inches long, horizontal in direction at the level of subcostal plane (L3) in front of the vertebral column toward the left side.

*It lies above the coils of the jejunum

Relations of the 3rd part of the duodenum

Anteriorly:

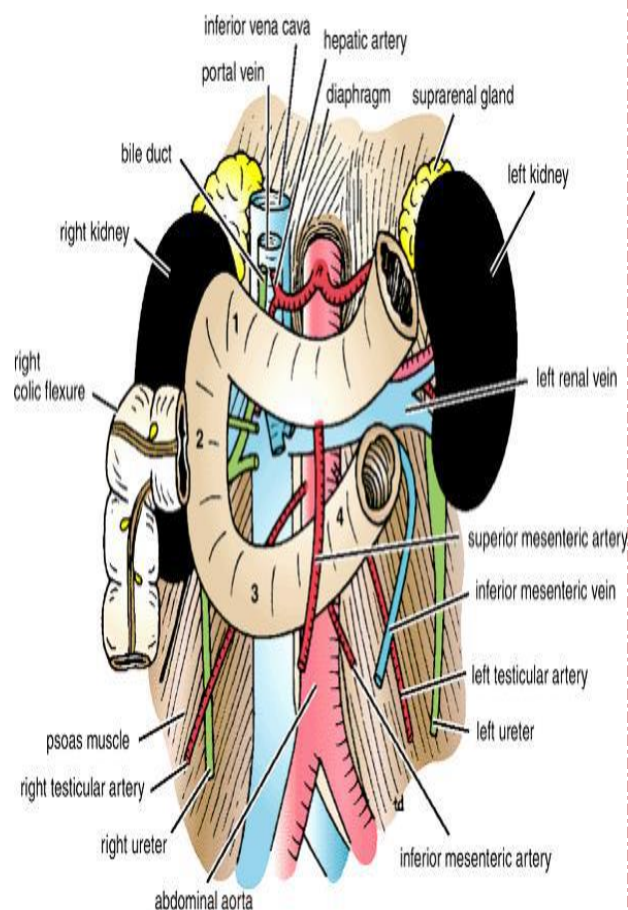
- 1- The root of the mesentery of the small intestines: because it passes obliquely from L2 on the left to terminates in front of the right sacroiliac joint on the right iliac fossa.
- 2- Superior mesenteric vessels (within the root of the mesentery)
- 3- Coils of jejunum

Posteriorly:

- 1- Right ureter
- 2- Right Psoas muscle
- 3- Inferior vena cava
- 4- Abdominal aorta
- 5- Origin of inferior mesenteric artery from the abdominal aorta (Important)

Superiorly: The head of pancreas

Inferiorly: Coils of jejunum



4th part of the duodenum:

It's 1 inch in length, Runs upwards to the left at the level of L2 it ends at the duodenojejunal junction, This junctions lies at the root of mesentery.

The duodenojejunal junction is held in position by ligament of treitz which is folds of peritoneum; this ligament extends from the duodenojejunal junction and attaches to the **right** crus of diaphragm (common question in the exam).

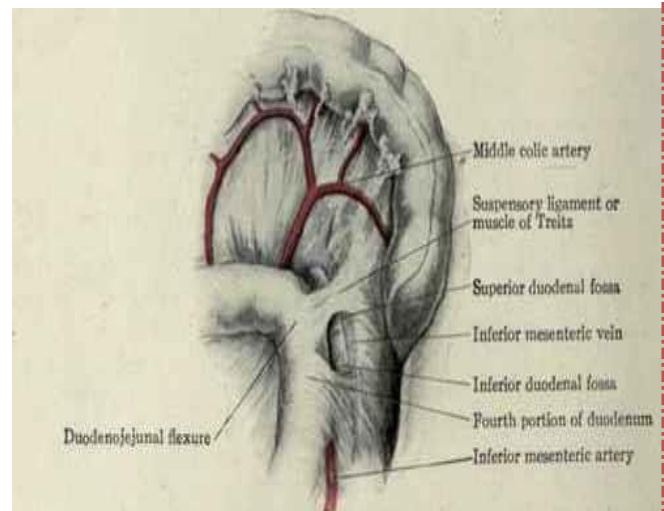
Relations of the 4th part of the duodenum

Anteriorly:

- 1- Root of the mesentery
- 2- Coils of jejunum

Posteriorly:

- 1- Left psoas muscles
- 2- Left Sympathetic chain
- 3- Left margin of the aorta



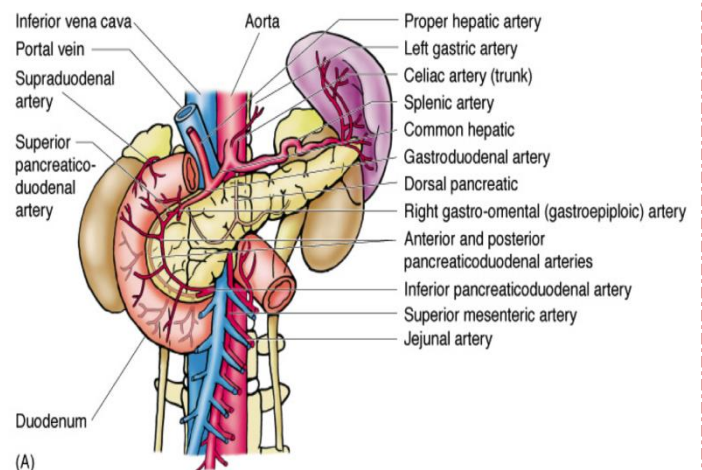
Superiorly: Uncinate process of the pancreas which is an extension from the head of pancreas.

Blood supply of the duodenum

In Embryology you will notice that the duodenum is divided into upper half and lower half by the opening of common bile duct and pancreatic duct.

The upper half -which includes the 1st part and the upper half of the 2nd part- belongs to the foregut and the lower half which includes the

2.36. Duodenum, pancreas, and spleen.



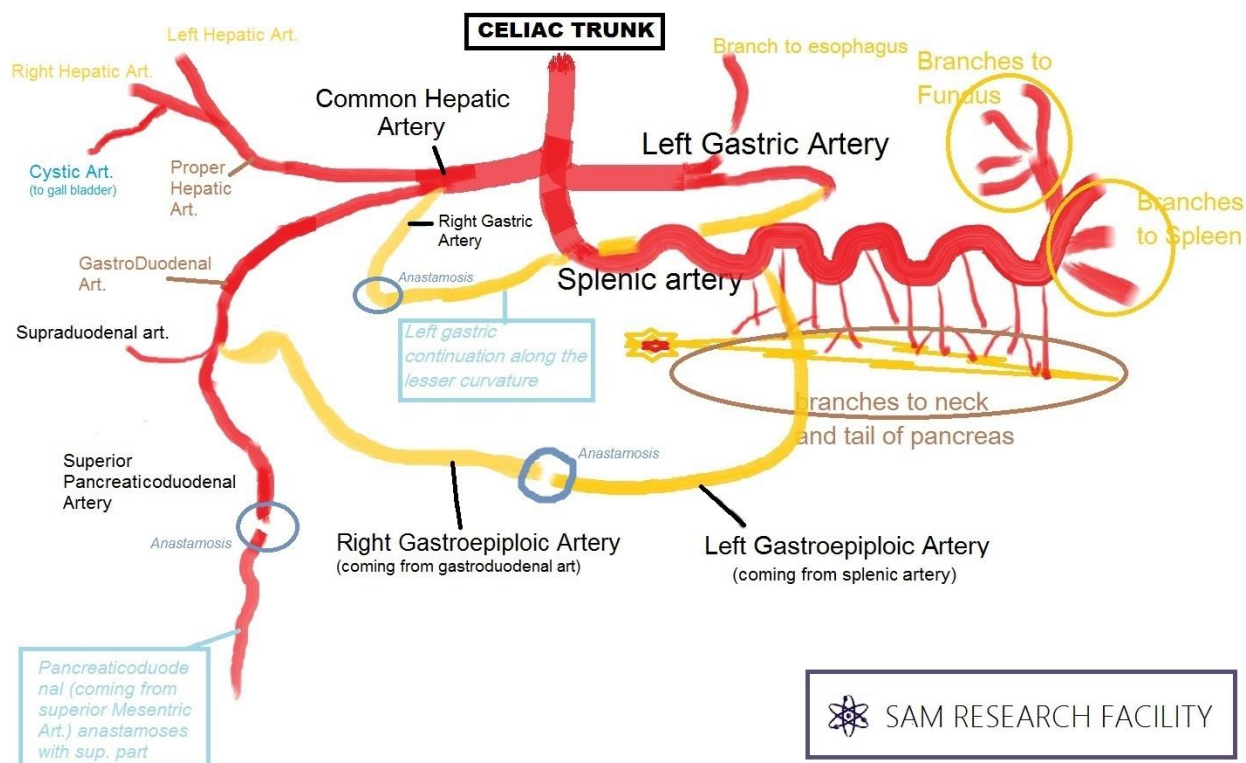
lower half of the 2nd part, 3rd .4th parts belongs to mid gut.

Blood supply to the upper half: anterior and posterior branches of superior pancreaticoduodenal artery *branch from gastroduodenal artery which comes from the celiac trunk

Blood supply to the lower half: anterior and posterior branches of inferior pancreaticoduodenal artery which is a branch from superior mesenteric artery.

Rule: content of the foregut is always supplied by branches of celiac trunk while the mid gut is supplied by branches from superior mesenteric artery . However, the hindgut contents are supplied by the inferior mesenteric artery.

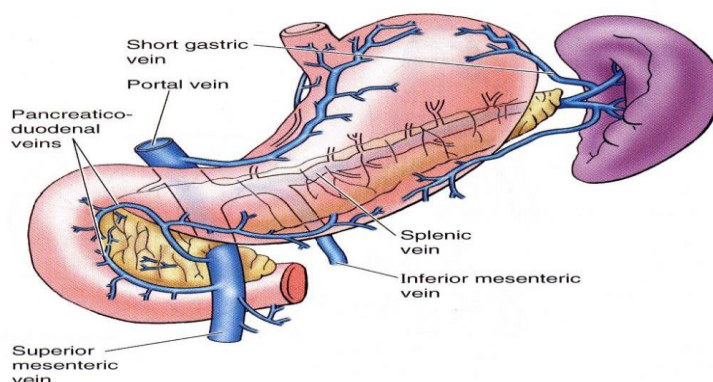
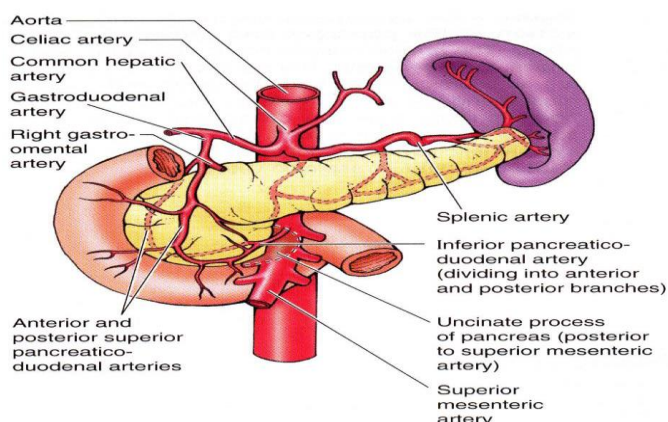
Celiac trunk gives left gastric, splenic (which is tortuous on the upper border of the pancreas) to spleen, and hepatic artery which gives gastroduodenal. Gastroduodenal artery gives right gastroepiploic and superior pancreaticoduodenal which divides into anterior & posterior superior pancreaticoduodenal. However, inferior pancreaticoduodenal is a branch from the superior mesenteric artery and it also divides into anterior & posterior branches.



Venous drainage of the duodenum

The venous drainage is the opposite of arterial supply. All the veins that drain the duodenum must ultimately drain into the portal vein. Upper half drain into superior pancreaticoduodenal vein and the lower half drains into inferior pancreaticoduodenal veins.

Superior pancreaticoduodenal veins drain directly to the portal vein, while the inferior pancreaticoduodenal veins drain into the superior mesenteric vein which joins with splenic vein to form the portal vein behind the neck of pancreas.

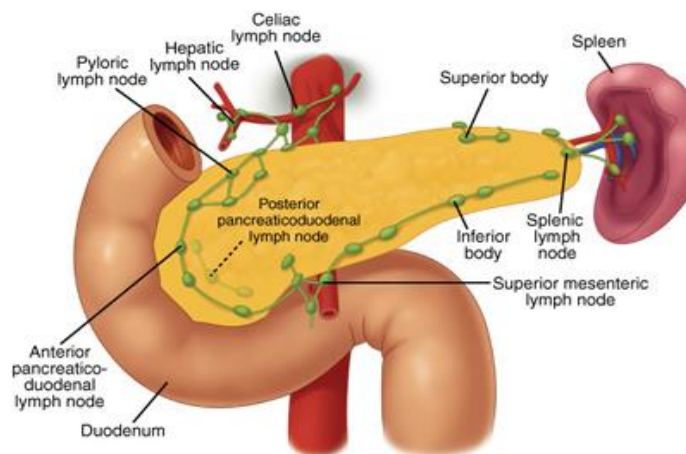


Lymphatic drainage of the duodenum

*Lymphatic vessels follow the arteries **

Upper half of the duodenum drain into pancreaticoduodenal nodes → gastroduodenal nodes → celiac lymph nodes

Lower half of the duodenum drains into pancreaticoduodenal nodes → Superior mesenteric lymph nodes located around the origin of superior mesenteric artery.



Source: Brunnicardi FC, Andersen DK, Billiar TR, Dunn DL, Hunter JG, Matthews JB, Pollock RE: *Schwartz's Principles of Surgery*, 9th Edition: <http://www.accessmedicine.com>
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Nerve Supply to the duodenum

- 1- Sympathetic innervations through splanchnic nerves (greater & lesser) which come from thoracic sympathetic chains.
- 2- Parasympathetic innervations from celiac plexus and superior mesenteric plexus through the vagus nerve.

Jejunum and Ileum

General characteristics about the jejunum and ileum

1. They measure about 6 meters long, located on the free edge of mesentery which is double fold of peritoneum comes from the posterior abdominal wall to the jejunum and ileum covering them completely that's why they are considered intraperitoneal organs.
2. The jejunum starts from the duodenojejunal junction located at the level of L2 1 inch to the left and the ileum terminates at the ileocecal junction, which is located 1 inch above the appendicular orifice, and it opens on the cecum at the right iliac fossa.
3. the main function of jejunum and ileum is secretion and absorption
4. The main histological characteristics: they have finger like projections called vili to increase the surface area available for absorption in addition to the presence of lacteals in the lamina propria for the absorption of fat.
5. * the coils of the jejunum and ileum are highly mobile and they are attached to the posterior abdominal wall by a fan shaped fold of peritoneum called mesentery of small intestine.

The mesentery of small intestines

This mesentery is fan shaped folds of peritoneum composed of:

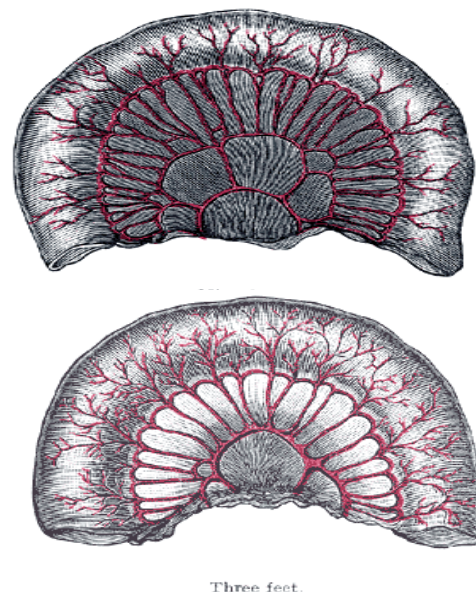
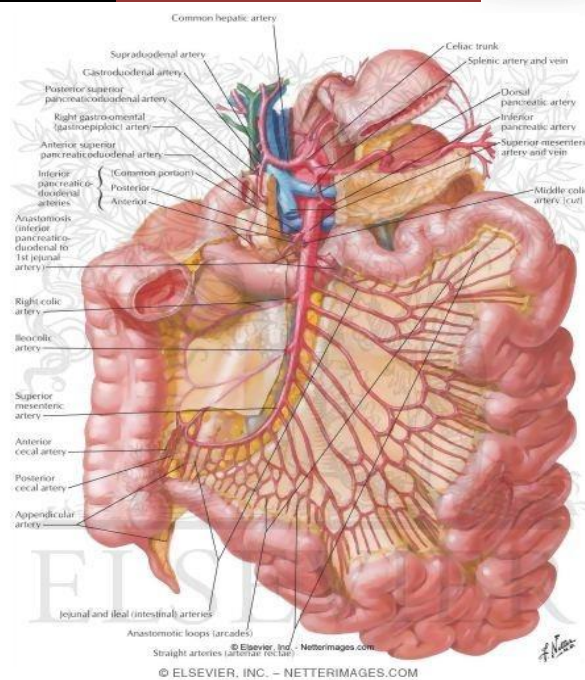
- 1- Root
- 2- Free edge
- 3- Breadth which is the space between the free edge and the root

The root of the mesentery is a double fold of peritoneum that is continuous with the parietal peritoneum in the posterior abdominal wall .It is 15 cm (6 inches) in length and 8 inches in width, starts at the level of L2, 1 inch to the left and descend obliquely to terminates in front of the right sacroiliac joint in the right iliac fossa.

Free edge of the mesentery is 6 meter in length (like the jejunum and ileum), it encloses the mobile intestines.

Content of the mesentery

- 1- Superior mesenteric artery and vein: the superior mesenteric artery forms important structures in the mesentery which are arcades and vasa recta. Arcades are loops of arteries that has a window like structures , coming from the arcades are the vasa recta they are straight and they head toward the intestines .There are distinctive differences between archades and vasa recta in the jejunum and ileum as we will see later .
- 2- Lymphatic vessels and lymphatic nodes
- 3- Nerves



Differences between the jejunum and the ileum

-depending on the structure of the jejunum and ileum it is very hard to distinguish them so we depend on the mesentery and the diameter of the jejunum and ileum.

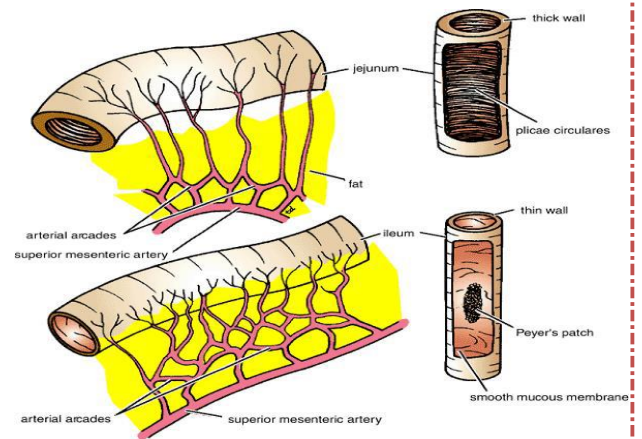
	Jejunum	Ileum
Length	Proximal 2/5	Distal 3/5
Diameter	Bigger	Smaller
Thickness of the wall	Thicker	Thinner
Color	More reddish	Less reddish
Fat amount in the mesentery	Small amount of fat Deposited near the root	Large amount of fat Deposited throughout the Mesentery
Arcades	Simple , only one or two layers of Arcades Long vasa recta	3 or 4 or even more layers of arcades (complicated) Short vasa recta
Villi	Numerous	Less numerous
Plicae circularis (important)	Larger and more numerous (a special characteristic of jejunum)	Smaller , widely separated And absent at the lower part
Lymphatic follicles	None or few	<u>Peyer's patches</u> which is Aggregation of lymphoid tissue Present in the mucous membrane (a special characteristic of ileum)

The differences between the jejunum and ileum always come in the practical exam

Arterial supply and venous drainage of the jejunum and ileum

-The jejunum & ileum are located in the midgut so it is supplied by superior mesenteric artery that forms arcades and vasa recta in the mesentery.

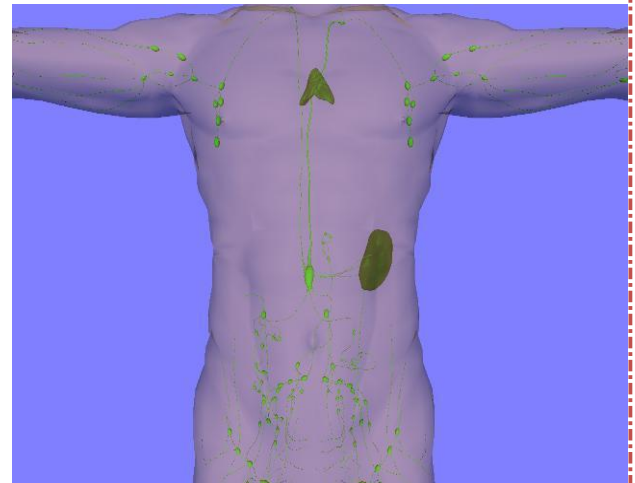
- They drain into the superior mesenteric veins which ultimately join with the splenic vein to form the portal vein.



Lymphatic drainage of the jejunum and ileum

*Lymph vessels pass through intermediate mesenteric lymph nodes to finally reach the superior mesenteric lymph nodes around the origin of superior mesenteric artery.

Cisterna chyli: it is a dilated sac of lymph in the abdomen that receives most of the lymphatic drainage of the abdomen, intestines, lower limb and pelvis. Then the thoracic duct arises from it to finally drain into the junction between left subclavian vein and left internal jugular vein (at the beginning of brachiocephalic vein).



Nerve supply of the jejunum and ileum

Sympathetic innervation: through greater and lesser splanchnic nerves that arise from the chest from the thoracic sympathetic ganglion from T6-T9

Parasympathetic innervation: from the superior mesenteric plexus through the vagus

Important point: the vagus nerve has very long pre-ganglionic nerve and short post-ganglionic nerve and it always synapse at the wall of the organ to form the Myenteric plexus (which contains a parasympathetic ganglion) and it's responsible for secretomotor

to the gland and responsible for peristaltic movement. While the sympathetic fibers, the pre-ganglionic nerve arise from sympathetic ganglion of the thorax (T6-T9) through splanchnic nerves and they synapse in the celiac trunk and superior mesenteric ganglion then the post-ganglionic nerve go to the organ, the post-ganglionic reaches the Myenteric Plexus but without synapsing it will be distributed to the blood vessels of the GI tract. This means that the sympathetic nerve fibers don't synapse at the wall of the organ like the parasympathetic they synapse in the celiac and superior mesenteric ganglion.

Differences between the small intestines and large intestines

	Small intestines	Large intestines
Length	6 meters (or more with duodenum)	Shorter, 1.5-2.5 meters (variation in length)
Diameter	Smaller	Larger
Function	Absorption of nutrients	Absorption of water and electrolytes And formation of feces
Nerve supply (IMPORTANT)	Parasympathetic by vagus Nerve Sympathetic by splanchnic Nerves	The large intestines is divided to Mid gut and hindgut at the lateral third of transverse colon. Lateral third (hindgut) Medial 2 thirds (midgut) Before the lateral third the innervations is the same as small Intestines that follow the midgut. After the lateral third: Parasympathetic innervations from S2-S4 sacral spinal nerves. Sympathetic innervations from Lumber sympathetic chains also Called <u>Hypogastric plexus</u> .

Peritoneum	- Duodenum → retroperitoneal except the first and last inch - Jejunum & ileum → Completely intraperitoneal and have mesentery.	Cecum ,appendix ,transverse colon & Sigmoid colon → Intra peritoneal Ascending colon ,descending colon & Rectum → retro peritoneal
Structure	Doesn't have tenia coli	Has tenia coli and apendicis Epiploicae

The surgical significance of retro and intra peritoneal organs

Intra peritoneal organs are highly mobile , I can manipulate it as much as I want, while retro peritoneal organs are fixed to the posterior abdominal wall and I can't manipulate that's why surgeries to the duodenum are hard for example because it is mostly retro peritoneal

For example : in the case of rectal cancer they remove the rectum and place a bag that connects the sigmoid colon to outside the anterior abdominal wall so that stool can pass through it this is called colostomy .Why did we choose the sigmoid colon ? Because it is intra peritoneal organ

Meckel's diverticulum

-It is a congenital anomaly of ileum caused from absent obliteration of Vitelline duct or yolk sac in embryo and the remnant of that duct will form Meckel's diverticulum .

-It's presented in 2% of the people, 2 feet away from the ileocecal junction, 2 inches long (kolhom 2 :P) , it contains gastric and pancreatic tissue.



- sometimes infection can happen in this diverticulum creating a clinical picture exactly like appendicitis, so in case of appendicitis like symptoms and you find a normal appendix you must go 2 feet away from iliocecal junction to find the diverticulum .
- Complications: Perforation, hemorrhage, infection.

THE END