



Anatomy

● Sheet

○ Slide

number

6

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Small intestine:

Before we start:

- All figures in this sheet are taken either from “Netter’s Atlas of Human Anatomy, 6th edition” or from “Slides”.
- To make this sheet shorter and easier, figures taken from Netter’s Atlas will be added in another file on the website. So, if you want to see them, please refer to the website.

In this lecture, we will talk about the small intestine. Duodenum, jejunum and ileum will be extensively discussed with their relations, blood supply, as well as their lymphatic and venous drainage. I will try to simplify things as much as I can.

This part is not mentioned in the lecture but I think that it’s really helpful.

- The gut of the embryo is divided into: foregut, midgut and hindgut. Each region gives rise to a part of the adult visceral abdominal structures. This helps in organizing our information about the blood supply and innervation of these parts.
Foregut the abdominal esophagus + upper half of the duodenum
Midgut the lower half of the duodenum + from the jejunum as far as the proximal two thirds of the transverse colon.
Hindgut the rest of the alimentary tract.

General Rule:

Foregut supplied by branches from the celiac trunk

Midgut supplied by branches from the superior mesenteric artery

Hindgut supplied by branches from the inferior mesenteric artery

Look at figure 1 (Plate 283 in Netter’s Atlas).

The celiac trunk gives 3 main branches:

1- Common Hepatic Artery: it gives 3 branches.

The right gastric artery + Gastroduodenal artery (we’ll come back to it in this lecture) + Hepatic artery proper

2- Left gastric artery

3- Splenic artery (which runs along the upper border of the pancreas in a tortuous course) **note:** splenic vein lies behind the body of pancreas so it's not in the stomach

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The small intestine is composed of the Duodenum , jejunum and ileum.

Duodenum

- It's a **retroperitoneal** structure except the first and last inches. Being retroperitoneal makes surgical manipulations on the duodenum difficult and risky.(it is fixed in its place)
- The first inch is intraperitoneal because it comes immediately after the stomach, which is also intraperitoneal (attached from above to the lesser omentum and to the greater omentum from below).
- The last inch is intraperitoneal because it comes immediately before the jejunum which is in the free edge of the mesentery, so it is also intraperitoneal.
- It lies in the epigastric and umbilical region (mainly in the epigastric).
- Length 10 inches (25 cm)
- C-shaped and has a concavity -to the left and backwards-, in which the head of the pancreas is present.
- It's divided into 4 parts, for descriptive purposes. Each part has its own relations and characteristics.
- Extension of the duodenum: from the pyloric orifice of the stomach to the jejunum.
- the lesser omentum is attached to the upper border of the 1st inch and the greater omentum is attached to its lower border. See Figure 2 (Plate 269 in Netter).

Extra info.

Below the free edge is the epiploic foramen (aka omental foramen/ foramen of Winslow) which reaches the lesser sac – which is behind the lesser omentum and the stomach .

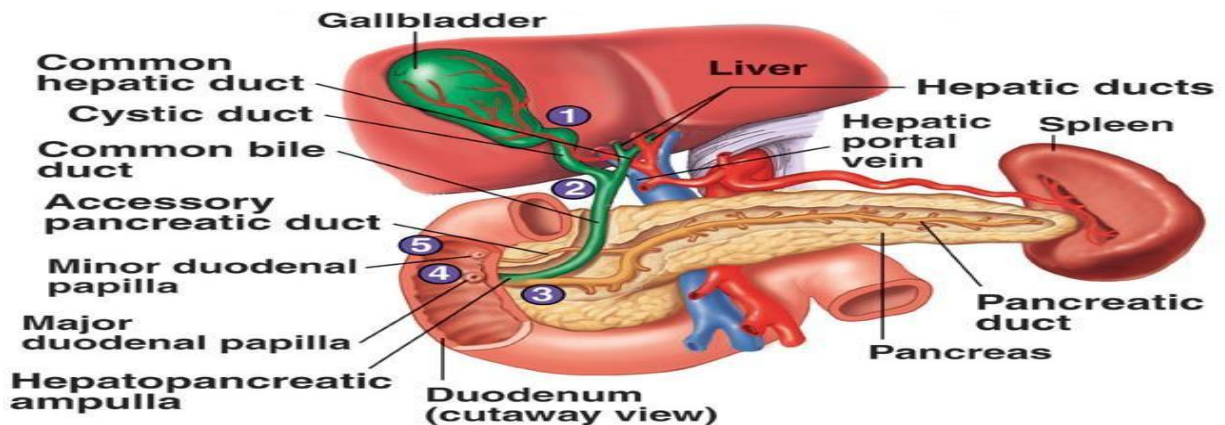
The spleen is positioned on the lateral side close to the greater curvature of the stomach but it is very small.

Question by the doctor..

If a patient had an infection behind the stomach and this infection caused fibrosis which of the following will not trouble the doctor when he opens up the patient ?

- A- Pancreas
- B- Splenic artery
- C- Kidneys
- D- **SPLEEN (the answer)**

- Parts of the duodenum:



- there are 2 hepatic ducts coming from the right and left lobes of the liver together they form the common hepatic duct which will be joined by the cystic duct thus forming the common bile duct.
- The common bile duct and the pancreatic duct open into the medial surface of the second part of the duodenum, in the major duodenal papilla.
- This opening is an important landmark, as it divides the duodenum into an upper half (belongs to the foregut) and a lower half (belongs to the midgut).
- There's an accessory pancreatic duct, in some individuals, that opens in the minor duodenal papilla, one inch above the opening of the major pancreatic duct and common bile duct as well (one inch above major duodenal papilla) .
- Pay attention to the celiac trunk and its branches in the figure above.
- Digestion of fat starts in the stomach by the gastric lipase, secreted by chief cells, and the lingual lipase, secreted by Von Ebner's glands, and it continues in the duodenum, as it receives bile salts and pancreatic digestive enzymes.
- Bile salts are amphipathic and aid in emulsification of fat.

Duodenum completes digestion.

Look at figures 3+4+5 (Plates 267+271+278)

1st of the duodenum

- length 2 inches
- the first inch is a common site for peptic ulcer.
- It starts at the pyloduodenal junction and ends at the neck of gallbladder at the level of transpyloric line (L1).

Relations of the first part: Look at Figure 6:

- **Anterior relations:**

The liver (quadratus lobe)

Gall bladder

- **Superior relations:**

The epiploic foramen (aka omental foramen/ foramen of Winslow).

Look at figure 5:

The free edge of lesser omentum

If you look inside the epiploic foramen, you will see the **portal triad**, arranged from superficial to deep as the following:

a- Common bile duct

b- Hepatic artery proper

c- Portal vein

- **Posterior relations:** (Very important) Look at figure 3:

1- the lesser sac (omental bursa)

In the abdomen, there's a greater sac (the abdominal cavity itself, inside the peritoneum) and a lesser sac (a space between the stomach and the pancreas, that forms part of the posterior relations of the 1st part of the duodenum).

2- Gastroduodenal artery (figure 1/ Plate 283).

3- Portal vein (formed behind the neck of the pancreas by the joining of splenic and superior mesenteric veins).

4- Inferior vena cava-which is posterior to foramen of Winslow.

the importance of relations 2/3/4 :

If there's peptic ulcer in the posterior wall of the first part of the duodenum, this can result in erosion of the Gastroduodenal artery, portal vein or inferior vena cava and thus bleeding.

5- bile duct

the importance of this relation

If there's peptic ulcer in the posterior wall of the first part of the duodenum, it can cause

injury in the bile duct allowing bile to go out causing peritonitis.*

* peritonitis : infection in the abdomen .

Inferiorly: figure 4 /plate 271 the head of pancreas. **Clinically: pancreatic cancer blocks the common bile duct thus causing obstructive jaundice since the bile returns to the blood.**

2nd part of the duodenum:

- Length 3 inches.
- It's also known as the *vertical/ perpendicular* part.
- The first part starts at the level of the transpyloric line (L1 level). The second part starts at the neck of the gallbladder and descends downward, until it reaches the level of L3.
- Along this way from the level of L1 to the level of L3, it passes from the neck of the gall bladder, in front of the right kidney and right ureter (See figure 4/ plate 271, the right kidney is shown clearly behind the 2nd part of the duodenum).

- The importance of the 2nd part:

- a- it receives the common bile duct and the main pancreatic duct (they open in the ampulla of Vater, at the major duodenal papilla).
- b- if the accessory pancreatic duct is present, it also opens here (at the minor duodenal papilla, one inch above the major papilla).

- Sphincter of Oddi: See figures 7&8

Oddi is an Italian physiologist and anatomist. However, he described this sphincter while being a student in the medical school. (Be like Bell Oddi).

- It's a valve around the ampull of Vater that controls the flow of digestive juice into the second part of the duodenum.
- when closed all the bile coming from the liver will go back to the gallbladder so the water will be absorbed and thus the bile is concentrated.
- The sphincter is closed when contracted and opened when relaxed. Since the parasympathetic system promotes GI functions, the sphincter is contracted by sympathetic stimulation and relaxed by parasympathetic stimulation and Cholecystokinin.
- ERCP: Endoscope Retrograde Cholangiopancreatography.
It's a technique used to treat many conditions. Example gallstones and the thickening of pancreatic duct secretions' due to pancreatitis.

Read this

https://en.wikipedia.org/wiki/Endoscopic_retrograde_cholangiopancreatography

y

And watch this

<https://www.youtube.com/watch?v=vnAtuG9ULB4>

Relations of the 2nd part:

Figure 9:

Anteriorly:

- 1- The gallbladder (fundus)
- 2- Right lobe of the liver
- 3- Transverse colon
- 4- coiled of small intestine.

Posteriorly:

- 1- Hilum of right kidney
- 2- Right ureter.

Laterally:

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

Medially:

- 1- Head of pancreas.
 - 2- Bile and pancreatic ducts.
-

3rd part of the duodenum:

- Length 4 inches
- Runs in a horizontal direction to the left along the subcostal plane (at the level of L3) , So it is also called horizontal part .
- It lies under the lower margin of the head of the pancreas, above the coils of the jejunum and in front of the vertebral column.

Relations:

Anteriorly: look at figure 4/ plate 271

- The root of the mesentery of the small intestine.
- Superior mesenteric vessels.(they cross this part of duodenum)
- coils of the jejunum.

Posteriorly: (all are clearly shown in figure 4)

Right psoas major muscle + Right ureter + abdominal aorta + inferior vena cava

Superiorly: figure 4

The head of the pancreas.

Inferiorly: (not shown in figure 4 but it's logical)

coils of the jejunum

4th part of the duodenum:

- Length 1 inch
- This part is intraperitoneal.
- Runs upwards to the left until it reaches the level of L2.

- It ends at the duodenojejunal junction at the level of L2. (same point of start to the root of mesentery) .
- This junction (flexure) is held in position by the ligament of Treitz (aka the suspensory muscle of the duodenum) it's formed by the thickening of 2 layers of peritoneum.
- Attachments:
It's attached to the duodenojejunal junction below and to the right crus of the diaphragm above. This is clearly show in figure 10/ plate 264.

Relations: Figure 4 /plate 271

Anteriorly:

- a- the beginning of the root of the mesentery
- b- coils of the jejunum

Posteriorly:

- Left psoas major muscle + left margin of the abdominal aorta + left sympathetic chain (not shown in the figure).

Superiorly:

The uncinete process of the pancreas. See figure 11.

• **Blood supply of the duodenum:**

- The duodenum is divided into an upper half and a lower half by the opening of the common bile duct. Above it is the upper half and below it is the lower half.

- The upper half belongs to the foregut supplied by branches from the celiac trunk.
- The lower half belongs to the midgut supplied by branches from the superior mesenteric artery.
- Upper half supplied by the superior pancreaticoduodenal artery.
Look at figure 1/ plate 283
Celiac trunk Hepatic artery gastroduodenal common superior pancreaticoduodenal Anterior & posterior superior pancreaticoduodenal arteries.
- Lower half is supplied by the inferior pancreaticoduodenal artery, a branch of the superior mesenteric artery.
Look at figure 12/ plate 284
Superior mesenteric common inferior pancreaticoduodenal artery anterior and posterior inferior pancreaticoduodenal arteries.
- See also figure 13/ plate 288
- Please, don't be confused with these names. Just see them in the figures and everything will be okay (I promise).
- Figure 14 summarizes the blood supply of the duodenum.

Venous drainage of the duodenum

The venous drainage is the opposite of the arterial supply. All the veins that drain the duodenum must ultimately drain into the portal vein.

- Upper half drain into superior pancreaticoduodenal vein.
- Lower half drains into inferior pancreaticoduodenal veins.
Superior pancreaticoduodenal veins drain directly into the portal vein, while the inferior pancreaticoduodenal veins drains into the superior mesenteric vein which joins with splenic vein to form the portal vein behind the neck of pancreas, then to the liver .
- See figure 15.

Lymphatic drainage of the duodenum

- The lymph vessels follow the arteries
- **Upper half** via pancreaticoduodenal nodes the gastroduodenal nodes the celiac nodes
- **Lower half** via pancreaticoduodenal nodes the superior mesenteric nodes around the origin of the superior mesenteric artery.

Nerve Supply to the duodenum

Autonomic innervation: Figures 18+19 (Plates 298+299).

1- Sympathetic (for sphincters) :

Greater and lesser splanchnic nerves

2- Parasympathetic (secretomotor for peristaltic movement) : from the vagus.

Together they form plexus of nerves :

a- celiac plexus

b- superior mesenteric plexus

Jejunum and Ileum

General characteristics about the jejunum and ileum:

- Length 6m
 - located on the free edge of the mesentery .
 - they are intraperitoneal structures .
 - There's no landmark that separates the jejunum from ileum but each one of them has distinctive features and thus there's gradual change in the characteristics of the small intestine that helps us distinguish between the two.
 - The jejunum starts at the duodenojejunal junction located at the level of L2.
 - 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.
 - 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 known as the mesentery of the small intestine. See figure 20/ plate 265.
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- Jejunum and ileum are in the umbilical region of the anterior abdominal wall.
 - The main function of jejunum and ileum is absorption.

- Histology of the small intestine: See figure 22
they have finger-like projections called villi to increase the surface area available for absorption.
 - There's a lymphatic capillary known as lacteal. It's important in the absorption of fat.
Read this: <https://en.wikipedia.org/wiki/Lacteal>
 - The mucosa is composed of simple columnar (absorptive) epithelium with goblet cells.
 - Plicae circulares (invagination of submucosa through the mucosa) are present in the wall of the small intestine.(**JEJUNUM**)
- Villi of the duodenum is called leaf like villi.
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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. Its length is 6 inches.
 - It is 15 cm (6 inches) in length and 8 inches in width.
 - Extension:
It starts at the level of L2, one inch to the left from the midline and descend obliquely to terminate in front of the right sacroiliac joint in the right iliac fossa.

The root **crosses** the following structures(common question) :inferior vena cava , abdominal aorta, sympathetic chain ,right psoas major muscle , right ureter , testicular vesicles ..

- **Free edge of the mesentery:**
 - 6 m
 - encloses the mobile intestine.
- **Contents of the mesentery:**
 - 1- branches from the superior mesenteric artery.
 - 2- lymphatic vessels and lymphatic nodes.
 - 3- sympathetic and parasympathetic nerves.

- Differences between ileum and jejunum:

See figure 23

-	Jejunum	- Ileum
- Length	- Proximal 2/5	- Distal 3/5
- Site	- In the upper part of the peritoneal cavity below the left side of the transverse mesocolon	- In the lower part of the abdominal cavity + the pelvic cavity
- Wall	- Thicker and more reddish	- Thinner and less reddish
- Arcades in the mesentery (Arcades are connections between the branches of the superior mesenteric artery). See figure 23	- Simple, one or two arcades with long infrequent branches. - long vasa recta	- Numerous - short terminal vessels arising from 3-4 or more arcades - short vasa recta
- Fat	- Small amount (mainly around the root the mesentery)	- Larger amount (present throughout the mesentery)
- Diameter	- Wider	- Smaller
- Villi	- Numerous	- Less
- Plicae circulares	- Larger and more numerous	- Smaller and less numerous (widely separated).
- Lymphatic follicles	- No or few	- Peyer's patches (aggregations of lymphoid tissue)

Arterial supply of the small intestine (See figure 24/ plate 287)

Jejunum and ileum arise from the embryonic midgut. So, they are blood-supplied by branches from the superior mesenteric artery.

- Look at the figure:

The differences between the jejunum and ileum in the number of arcades and the length of vasa recta are clearly shown.

- Memorize the following information from the figure:

As the superior mesenteric artery is descending downward, many intestinal branches (jejunal and ileal arteries) arise from its left side. Then, these branches run in the mesentery and finally anastomose with each other forming arcades. From these arcades, terminal straight branches arise. Since they are straight, they are known as vasa rectae or arteriaerectae.

- The lower part of the ileum is also supplied by the ileocolic artery, that arises from the right side of the superior mesenteric (also shown in the figure).

- **Venous drainage:**

The veins correspond to the branches of the superior mesenteric artery and they drain into the superior mesenteric vein.

- **Lymphatic drainage of the jejunum and ileum:**

Lymph vessels pass through many intermediate mesenteric lymph nodes and they finally reach the superior mesenteric lymph nodes around the origin of the superior mesenteric arteries. (See figure 17/ plate 261).

- See figure 25:

Cisterna Chyli: a dilated lymphatic sac that's present in the orifice of abdominal aorta in the diaphragm all lymph from the abdomen and lower limbs drains here.

Thoracic duct: it arises from the cisterna chyli and goes upward until it reaches the left brachiocephalic vein, where it drains its contents.

Nerve supply of the jejunum and ileum

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

Parasympathetic innervation: from the superior mesenteric plexus through the vagus nerve.

See figure 26

Note that the vagus nerve doesn't synapse in the celiac and superior mesenteric ganglia but it does synapse in the myenteric plexus which makes it mainly parasympathetic .

Meckel's Diverticulum:

See figure 27/ taken from Netter's Clinical Anatomy, 3rd edition.

- A congenital anomaly of the small intestine.
- The most common congenital anomaly of the GI tract.
- Results from failure of obliteration of the vitelline duct (located between ileum and umbilicus) in the embryo. The remnants of the duct form "Meckel's diverticulum".
- Diverticulum means a pouch or sac that's coming out of a hollow organ (intestine, bladder..etc).
- Known as the syndrome of twos:
present in 2% of the population
2 feet from the ileocecal junction
2 inches long
contains two types of mucosa (gastric or pancreatic tissue)

- Complications of Meckel's Diverticulum:

- 1- Infection (Diverticulitis) this can be mis-diagnosed as appendicitis (they both have the same symptoms).
- 2- Perforation:
and this results in peritonitis.
- 3- ulceration

See figure 28

what is the difference between small intestine and large intestine ?

	Large intestine	Small intestine
Length	1.5 – 2.5 M	6 M
Diameter	Larger	Smaller
Function	1- Absorption of water 2- formation of feces	Absorption
Location	1-Part is retroperitoneal (ascending and descending colon , rectum and anal canal) 2- part is intraperitoneal (transverse colon , sigmoid colon , appendix , cecum)	Was mentioned previously
Specific characteristic	1- Saculation 2- taenia coli 3- tags of fat (these 3 characteristics will be discussed in the next sheet)	There isn't any.

THE END