

THE



SYSTEM

Anatomy

Sheet

Slide

Handout

Number: **5**

Subject: **Small Intestine**

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Date: **0/0/2016**

Price:

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

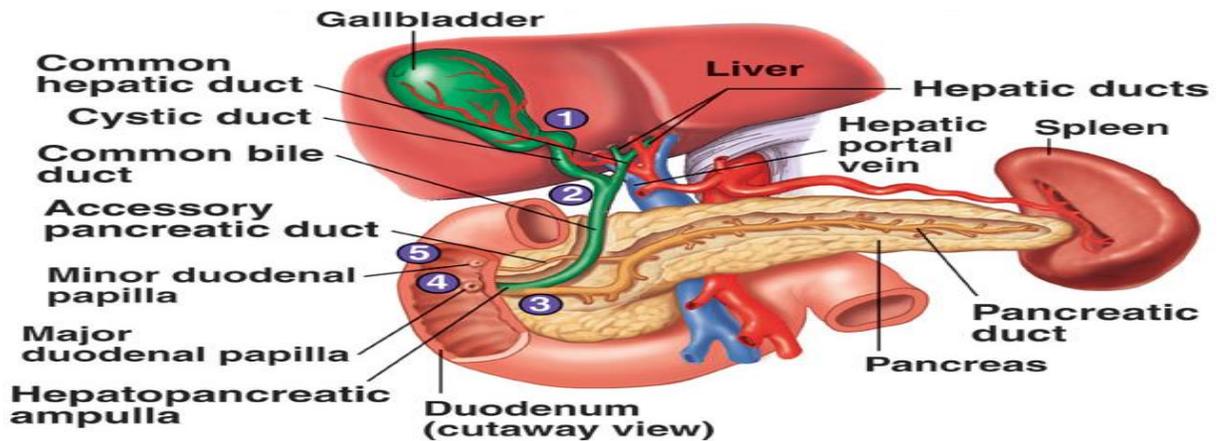
Hindgut → supplied by branches from the inferior mesenteric artery

- 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).
-

Duodenum

- It's a retroperitoneal structure except the first and last inches. Being retroperitoneal makes surgical manipulations on the duodenum difficult and risky.
 - The first inch is intraperitoneal because it comes immediately after the stomach, which is also intraperitoneal.
 - The last inch is intraperitoneal because it comes immediately before the jejunum, which 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, 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).
-

- Parts of the duodenum:



- 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.

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- 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

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

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 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 control the flow of digestive juice into the second part of the duodenum.
- 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. One of them is gallstones.

Read this

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

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:

- Head of pancreas.
 - 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 jejunum:

- 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).
 - 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 + sympathetic chain (not shown in the figure).

Superiorly:

The uncinata 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) :

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.
-
- 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 epithelium with goblet cells.
 - Plicae circulares (invagination of submucosa through the mucosa) are present in the wall of the small intestine.
 - Jejunum and ileum are in the umbilical region of the anterior abdominal wall.
-

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.

- **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.

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

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)

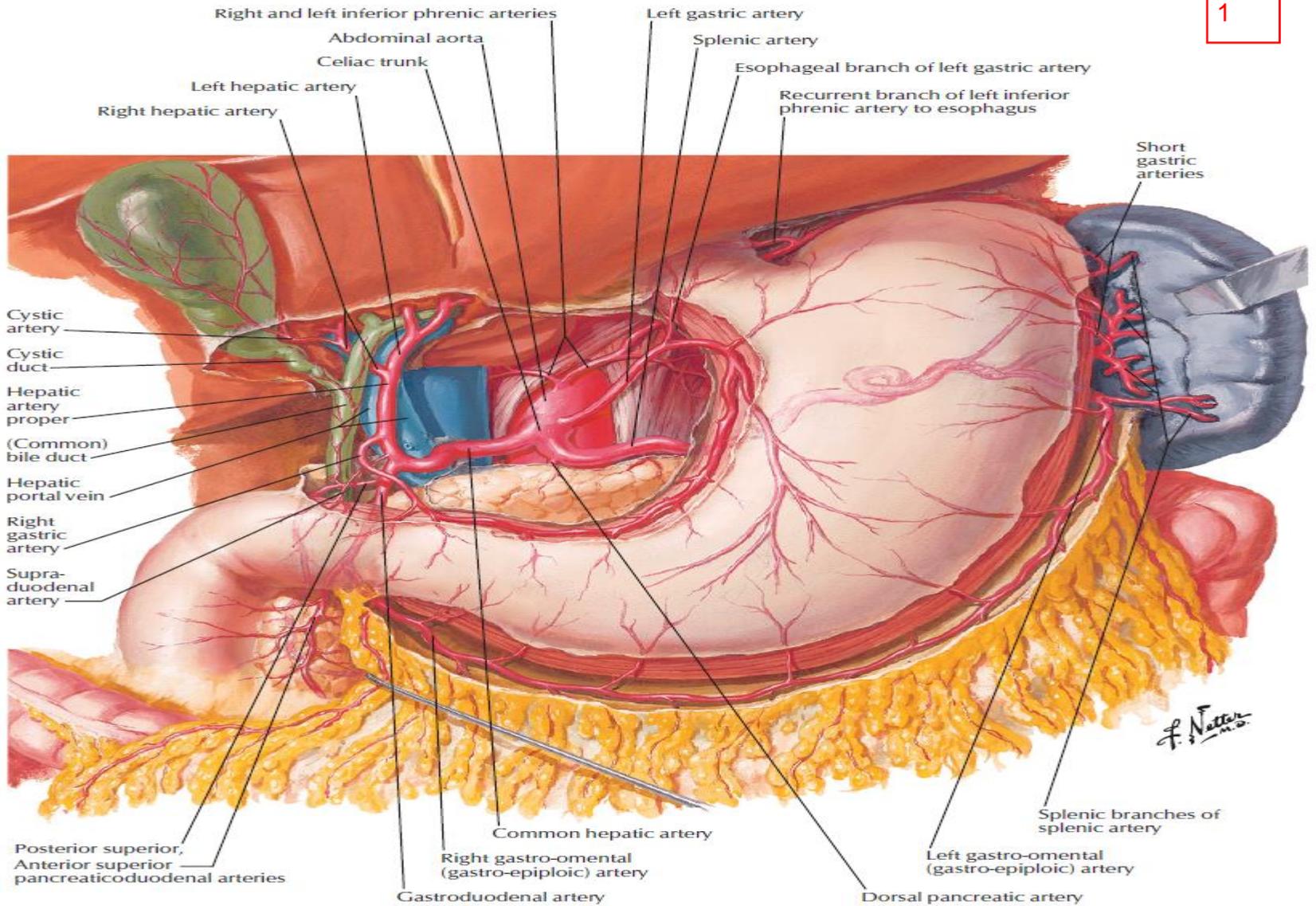
- Complications of Meckel's Diverticulum:

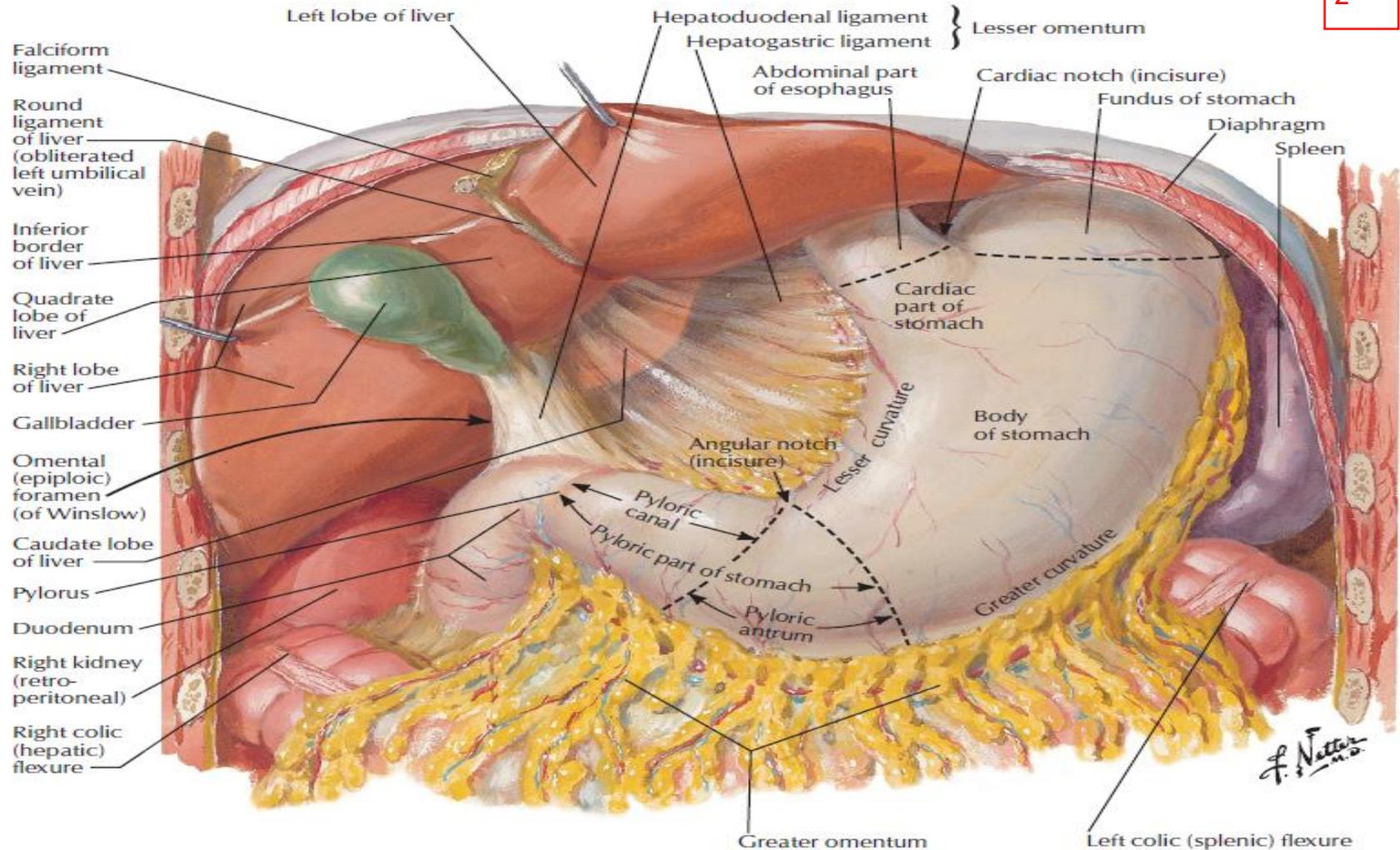
- 1- Infection (Diverticulitis) → this can be mis-diagnosed as appendicitis (they both have the same symptoms).
 - 2- Perforation:
and this results in peritonitis.
 - 3- ulceration
- See figure 28

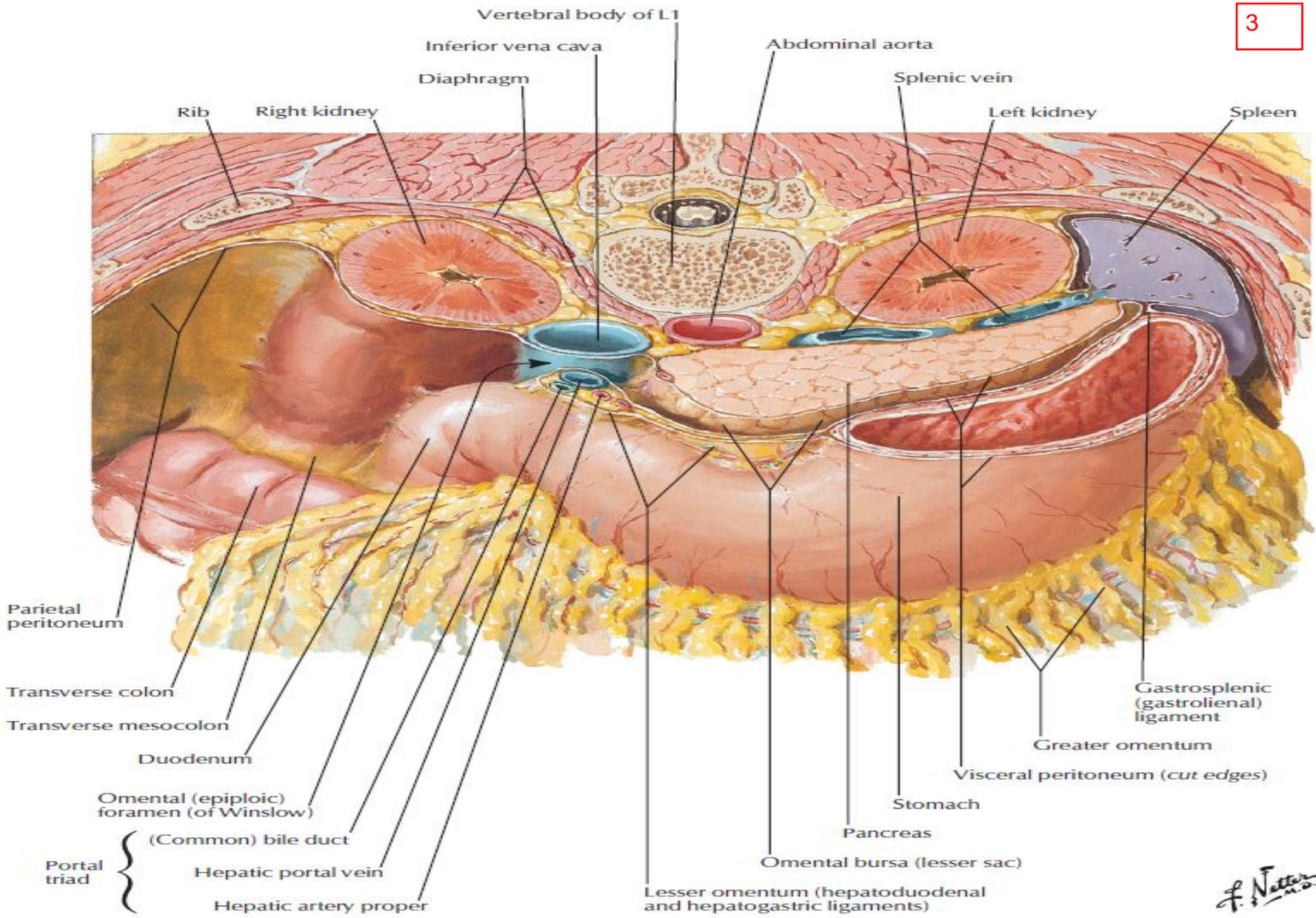
what is the different between small intestine and large intestine ?

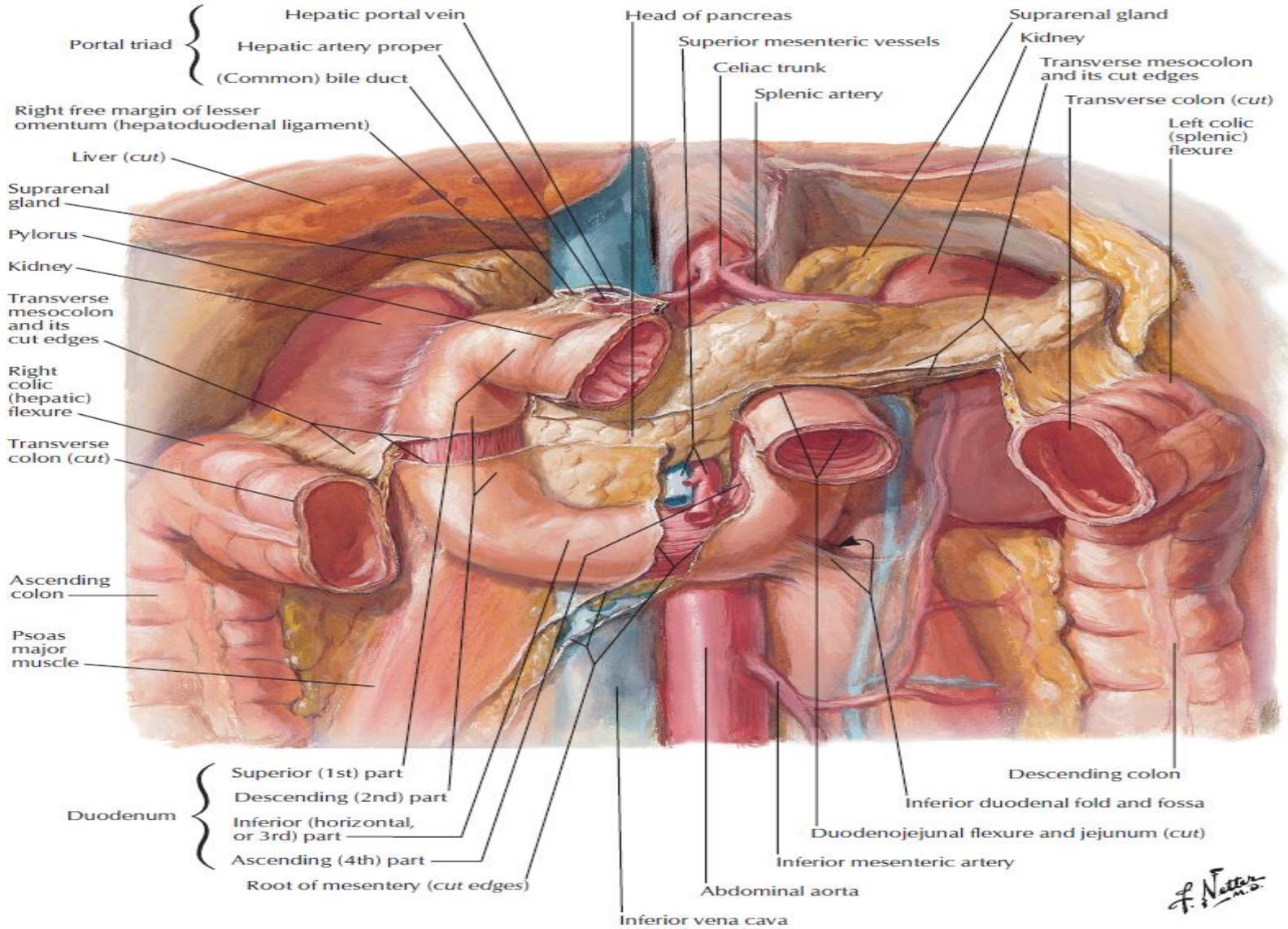
	Large intestine	Small intestine
Length	1.5 – 2.5 M	6 M
Diameter	Larger	Smaller
Function	1- Absorption of water 2- formation of feces	Absorption
Location	1-Part is retroperitoneal (ascending and descending colon , rectum and anal canal) 2- part is intraperitoneal (transverse colon , sigmoid colon , appendix , 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 is no any of them

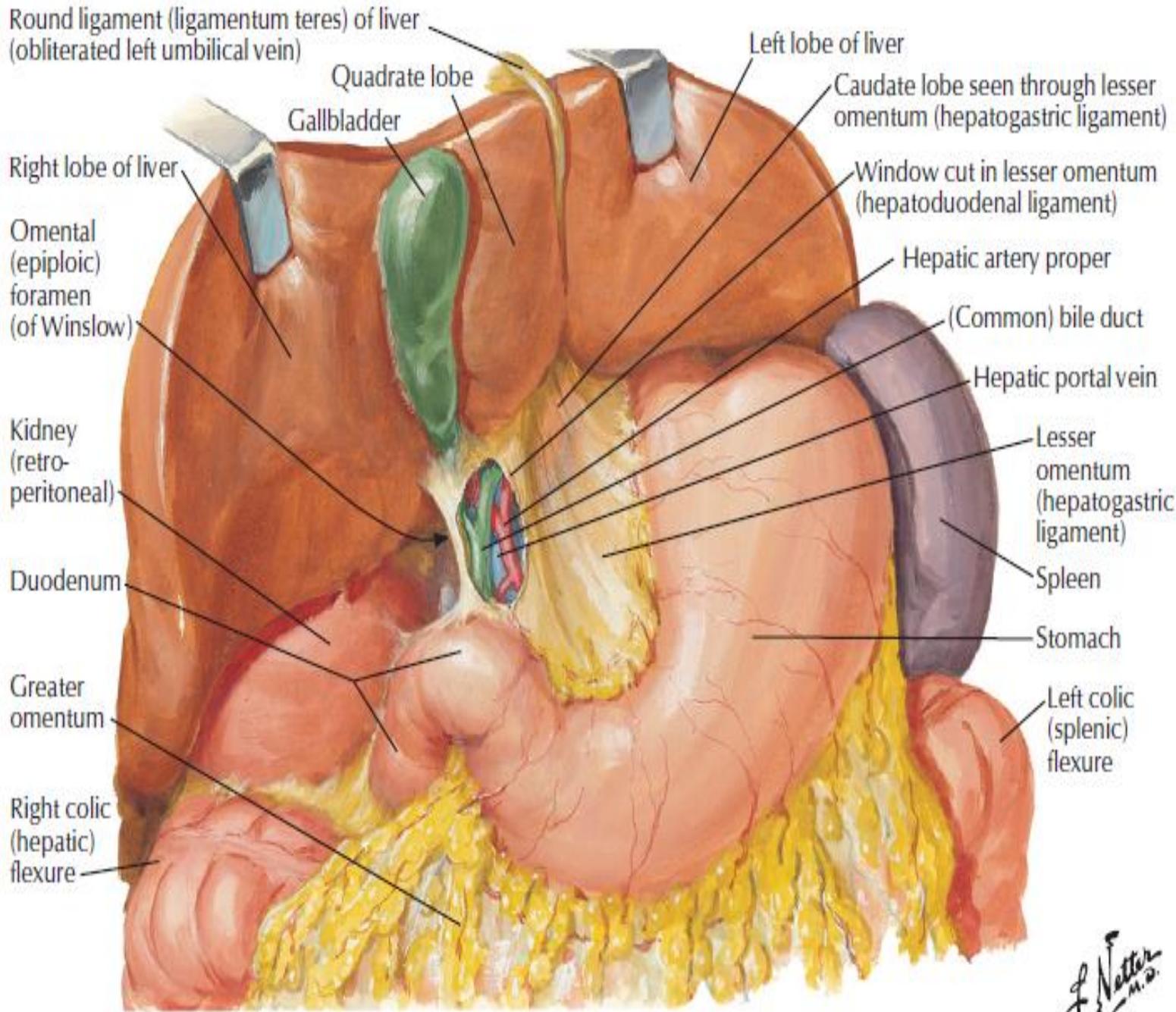
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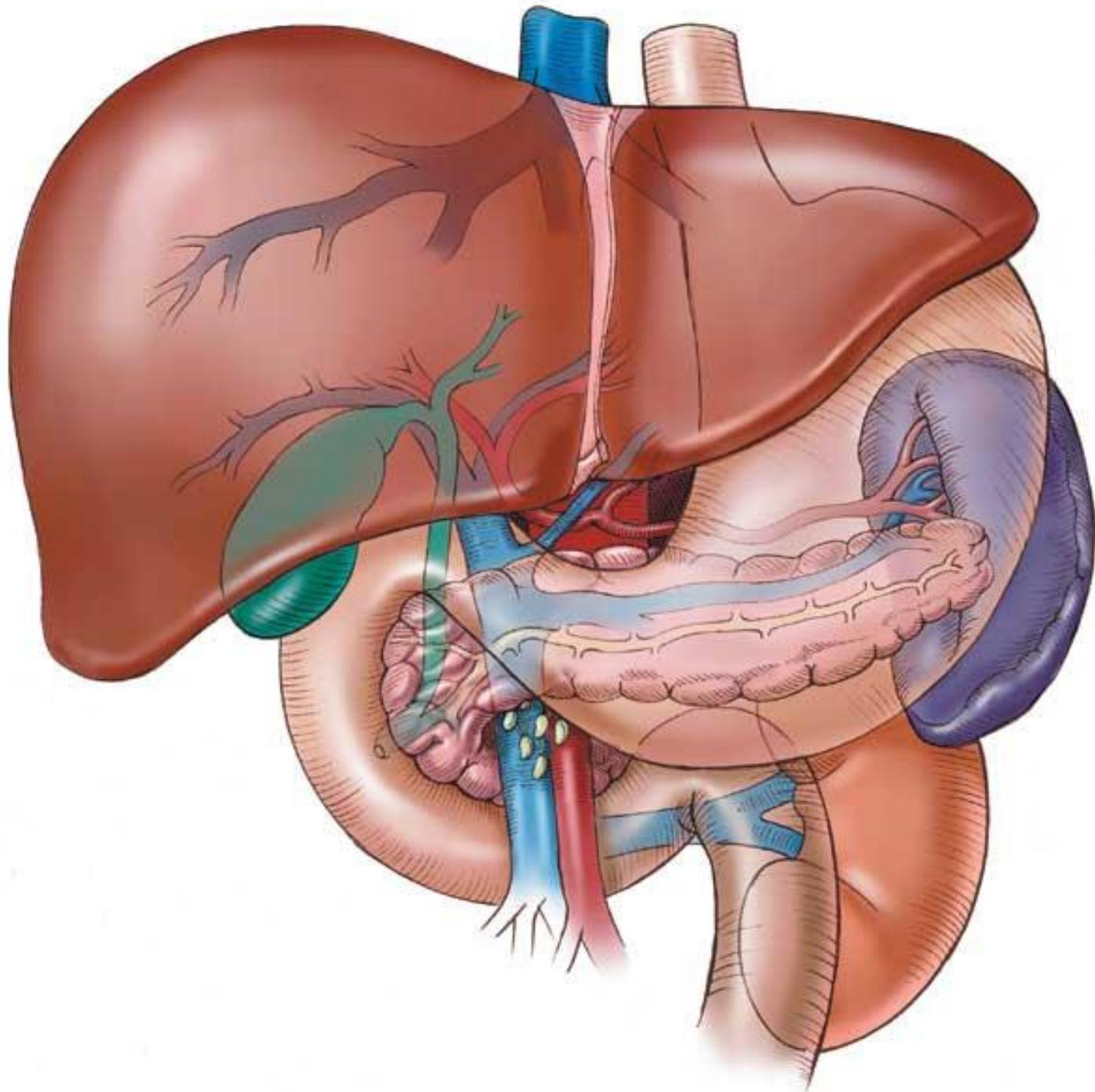










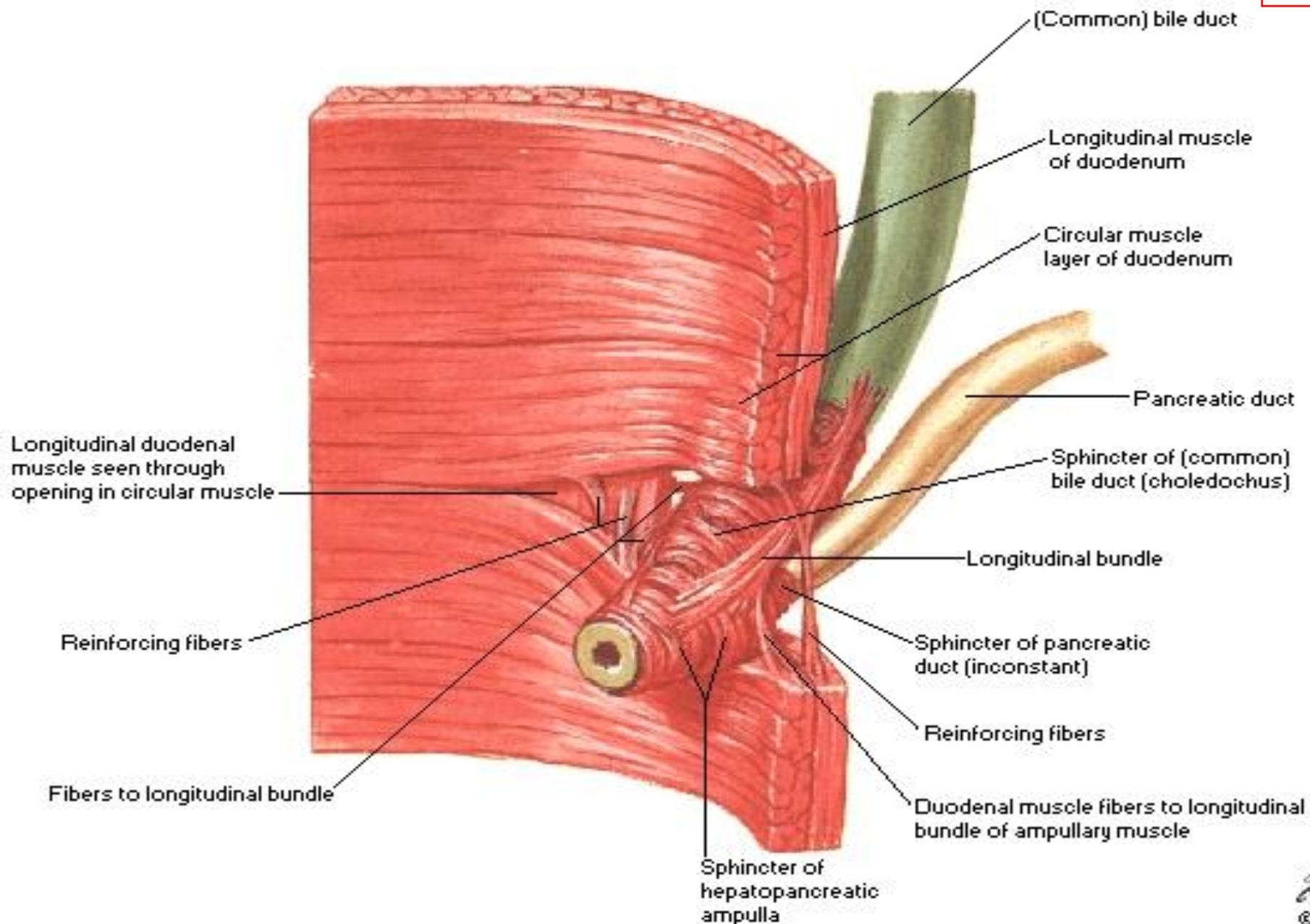


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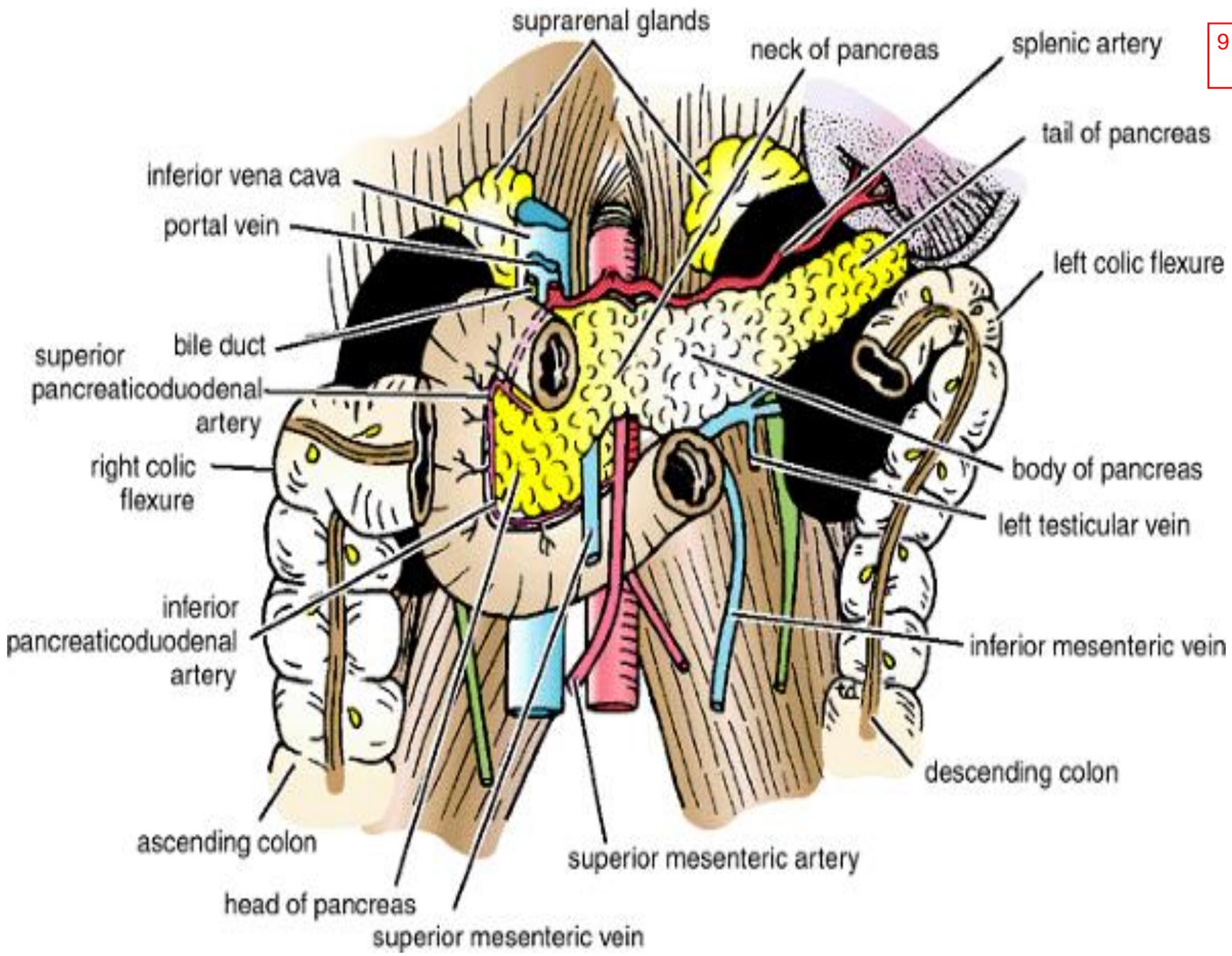
Junction of Bile Duct and Duodenum

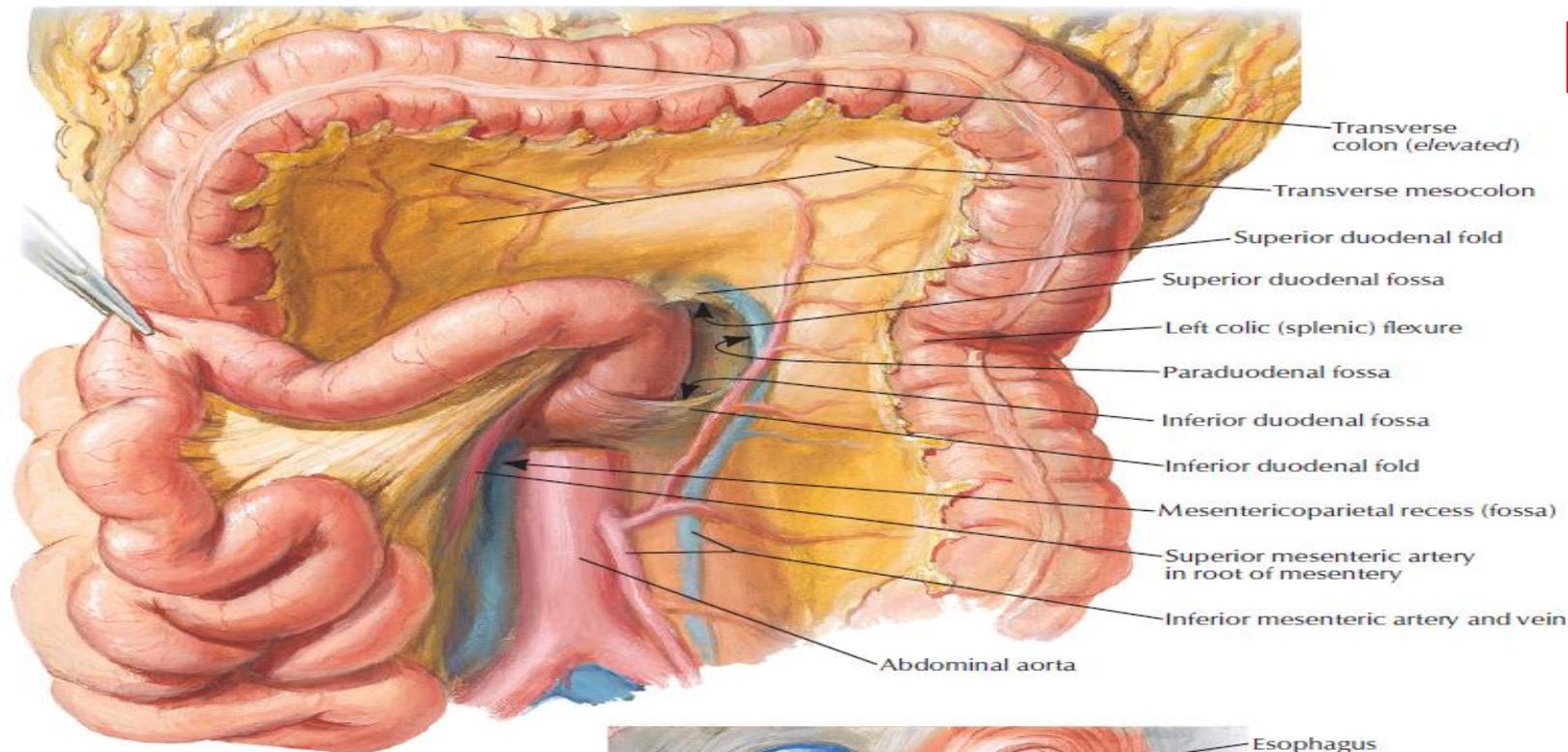
Dissection

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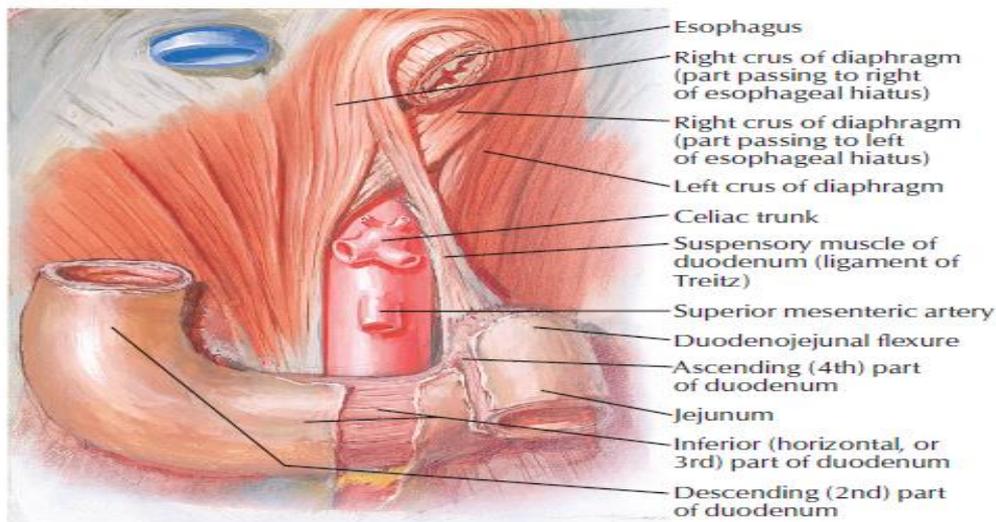




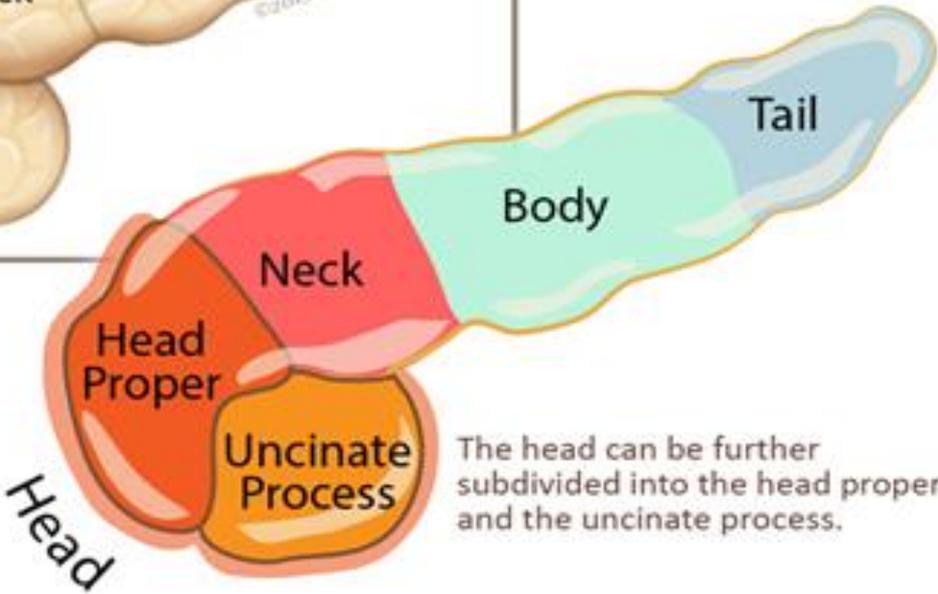
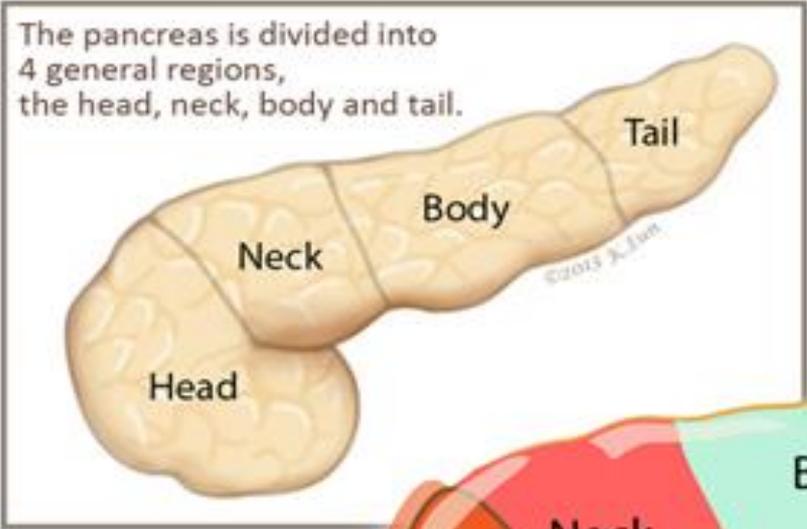


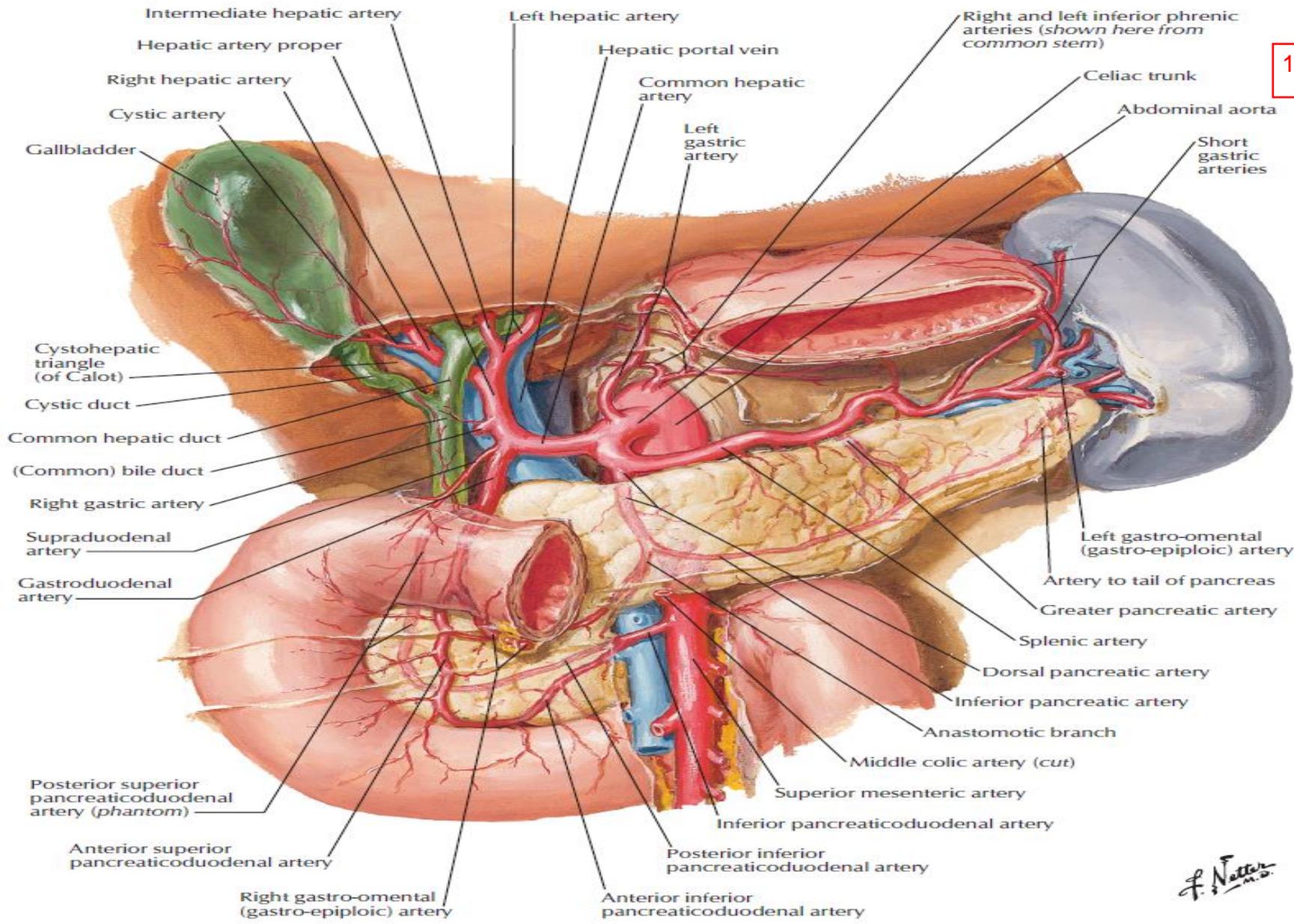


Exposure of suspensory muscle of duodenum (ligament of Treitz)

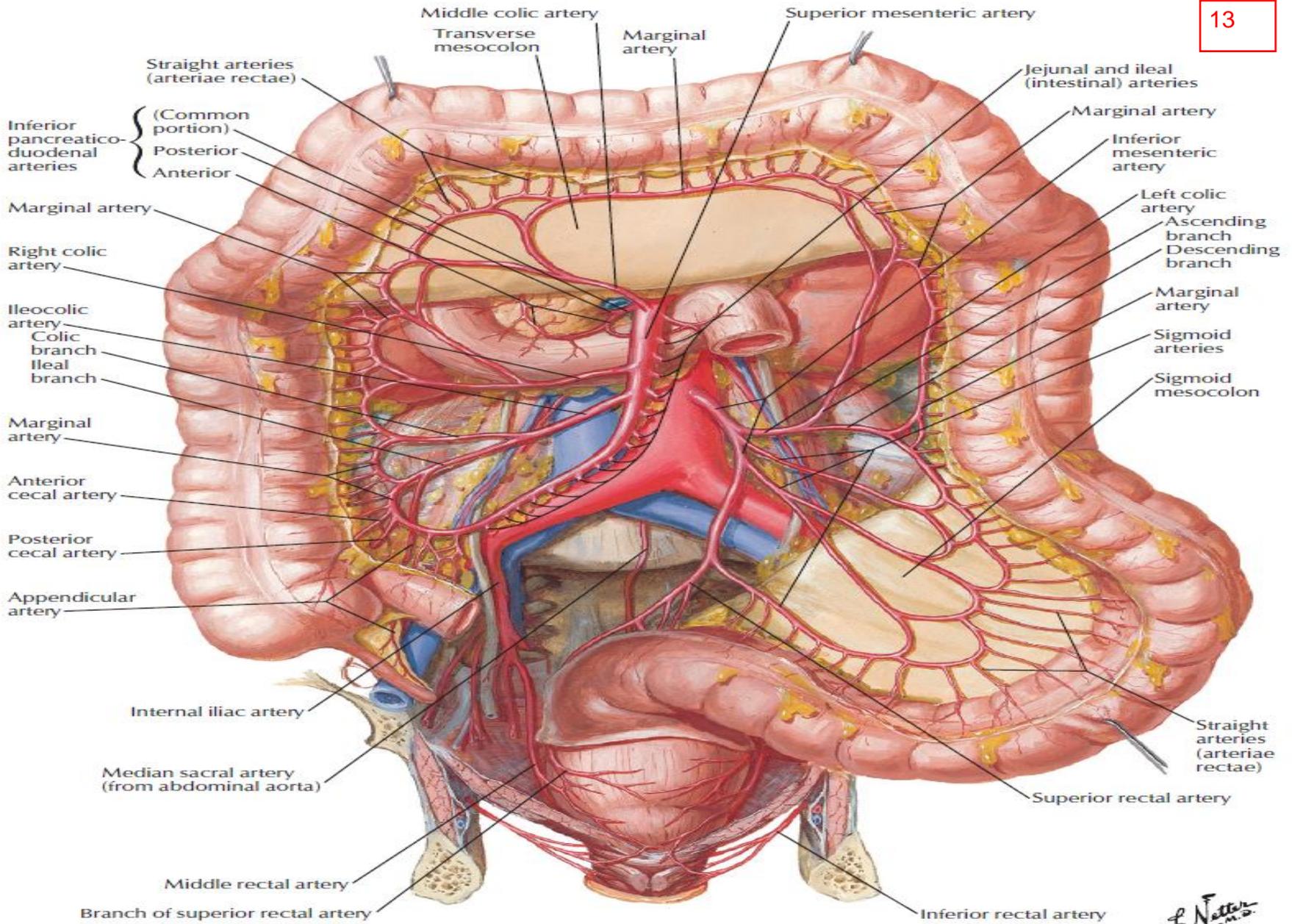


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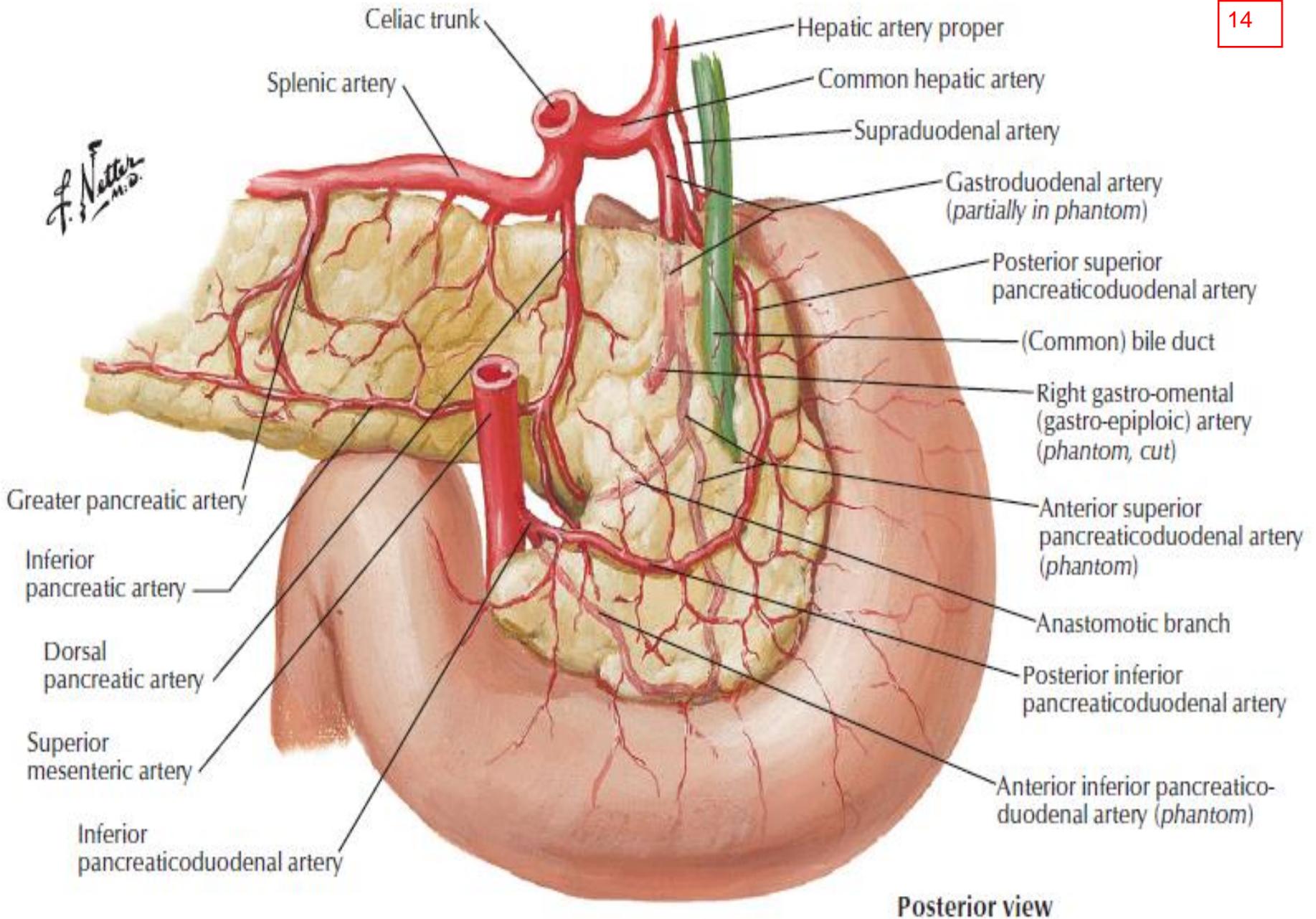


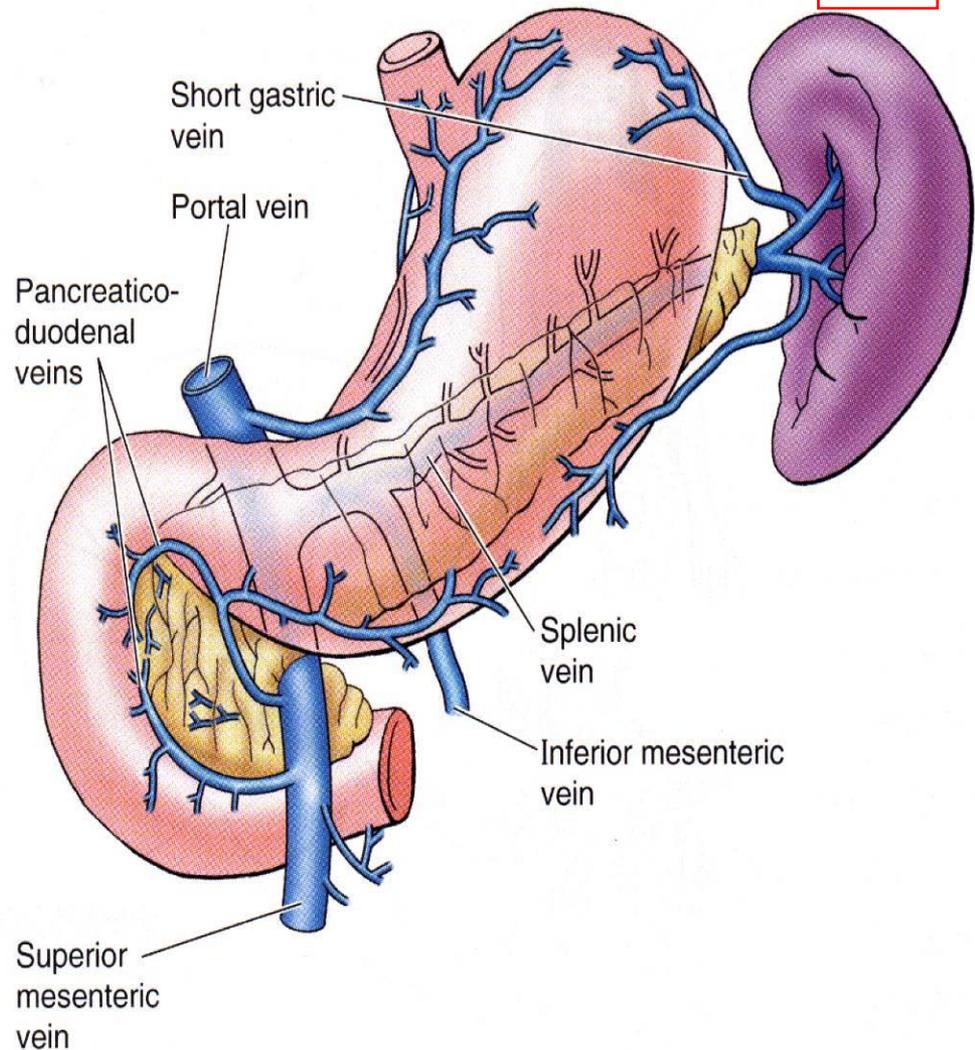
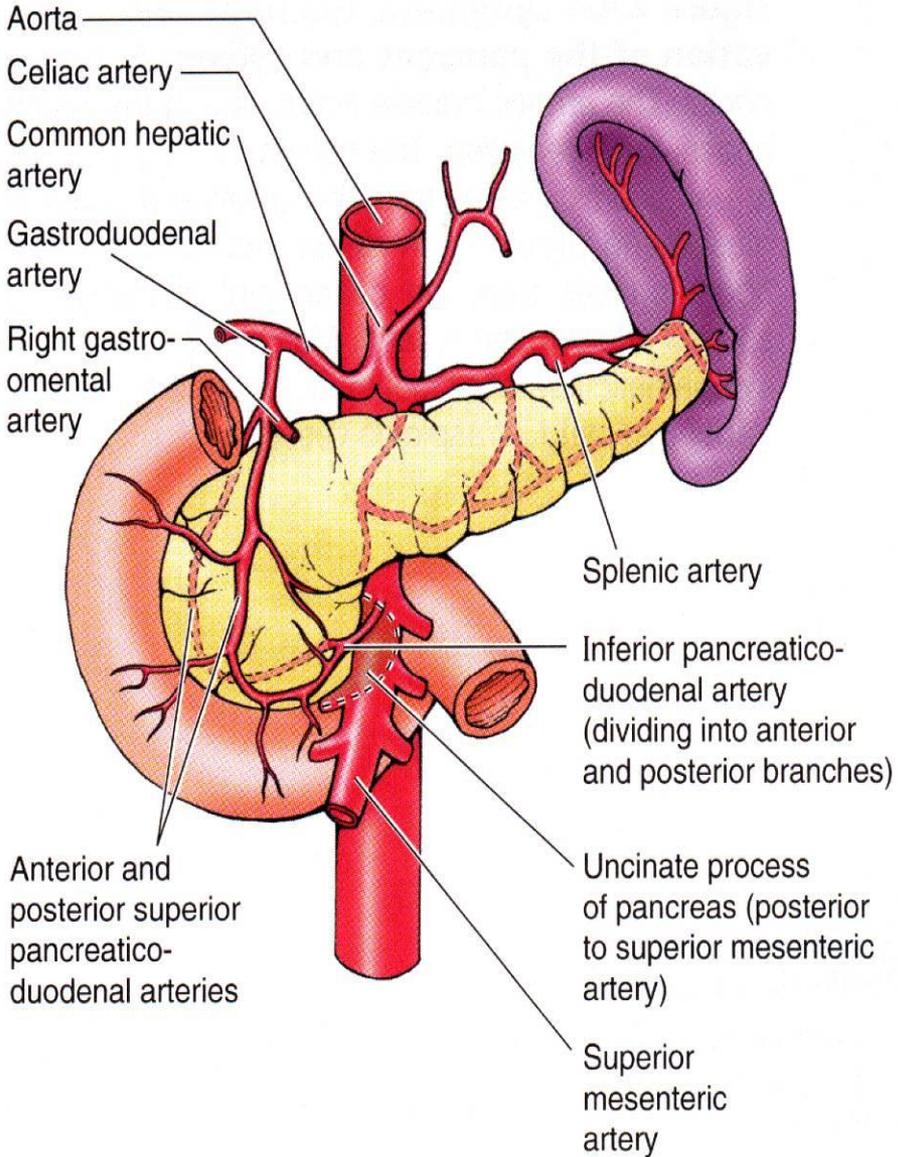


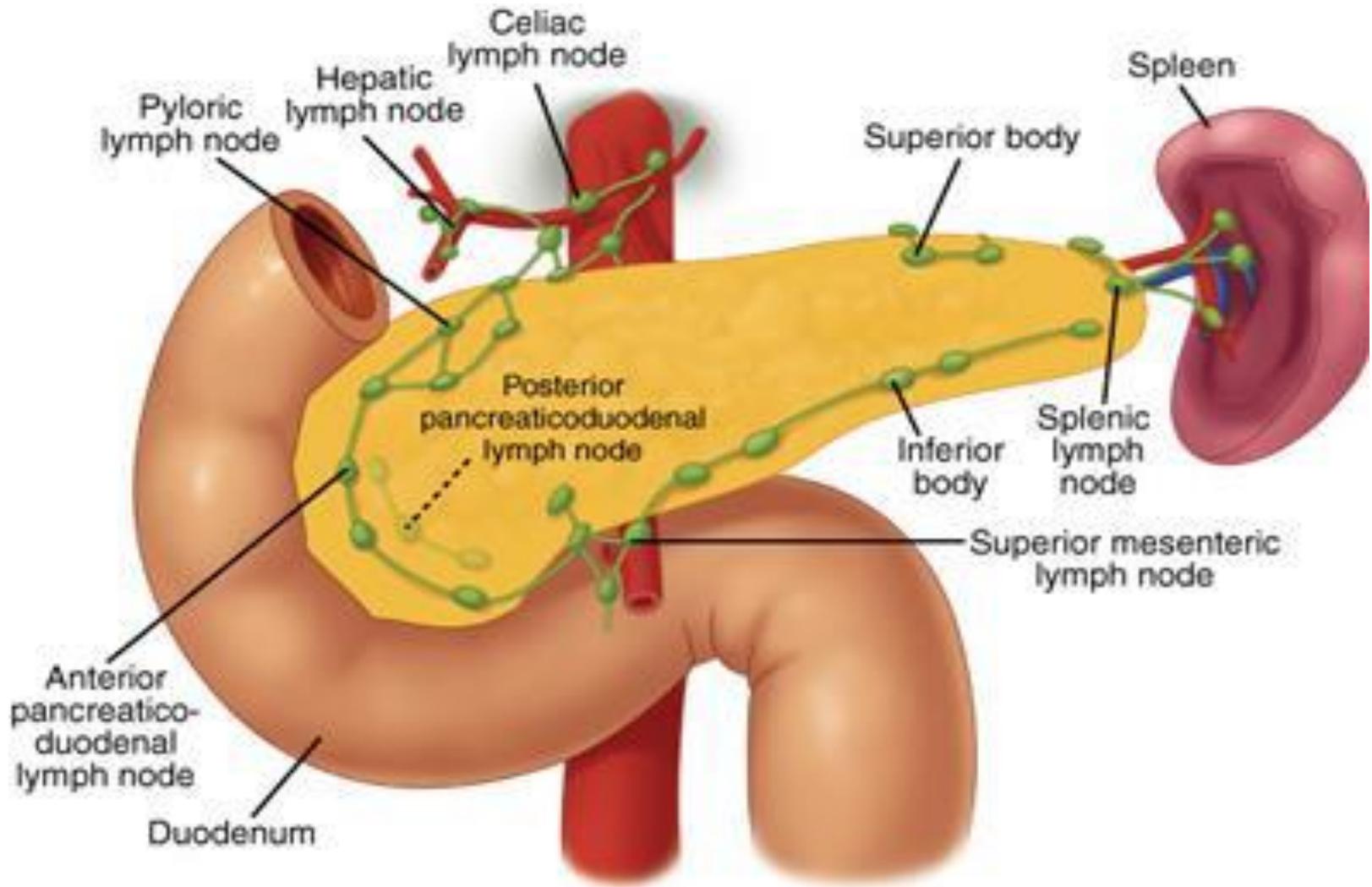
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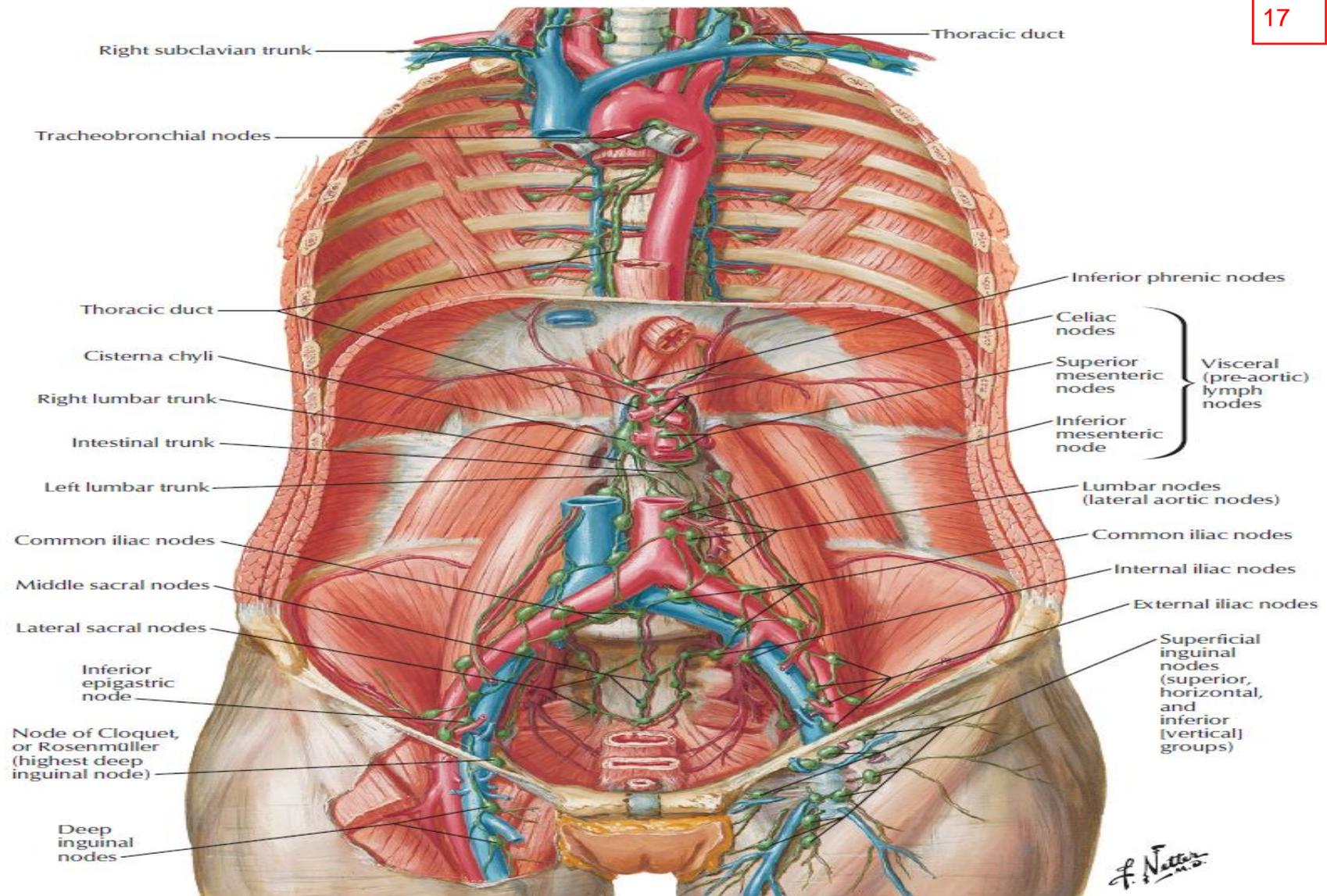
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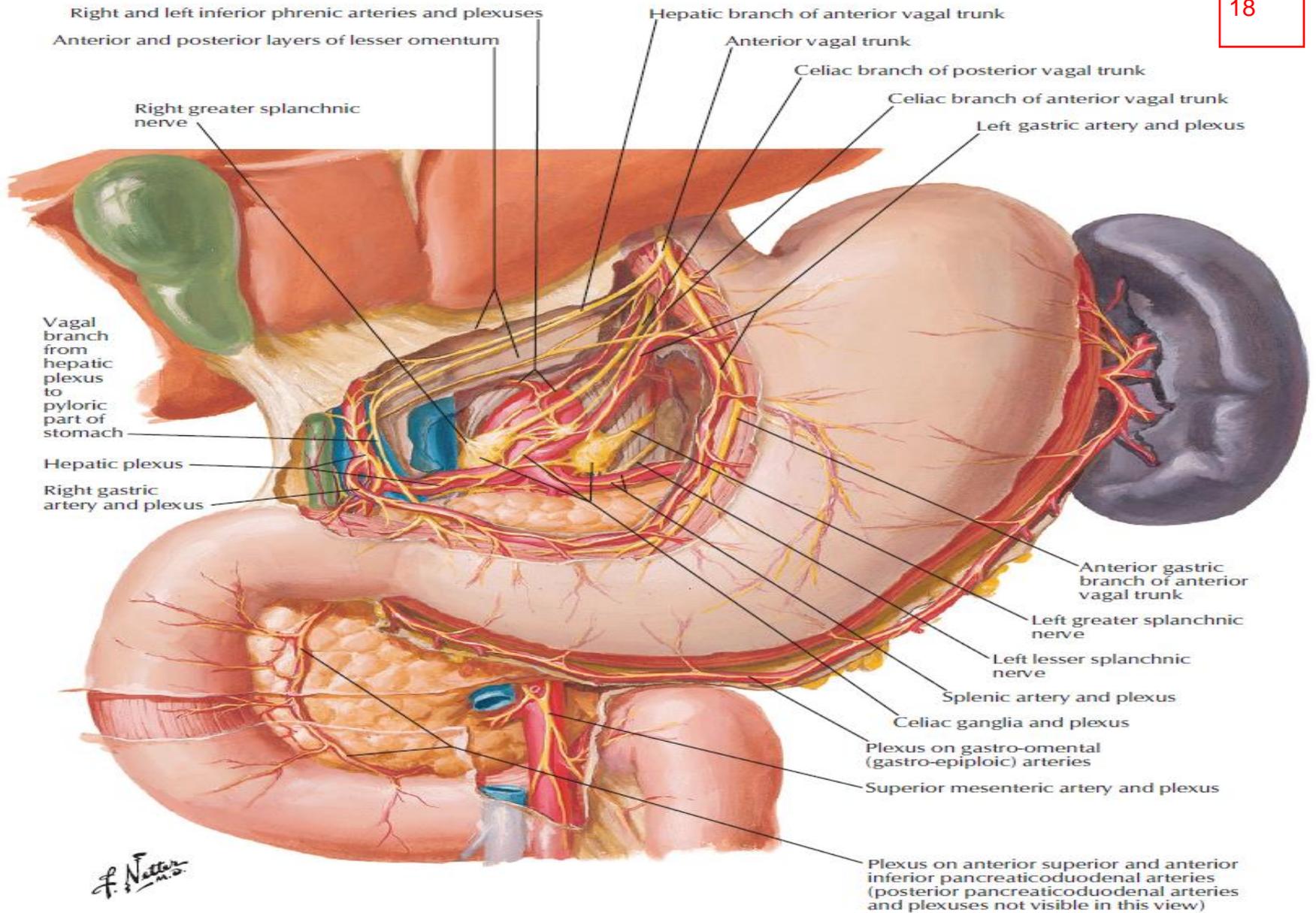


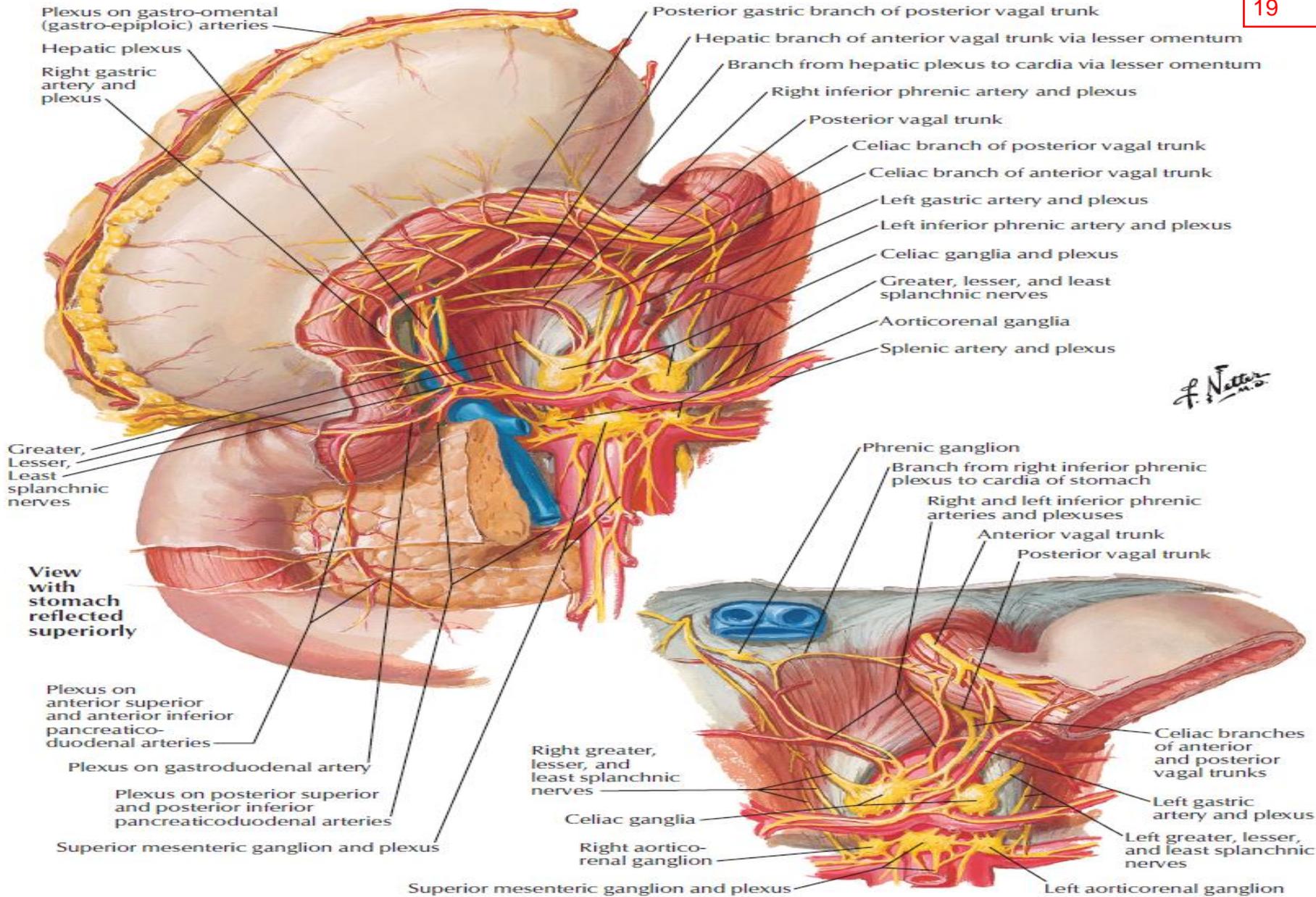




Source: Brunicaardi FC, Andersen DK, Billiar TR, Dunn DL, Hunter JG, Matthews JB, Pollock RE: *Schwartz's Principles of Surgery, 9th Edition*; <http://www.accessmedicine.com>
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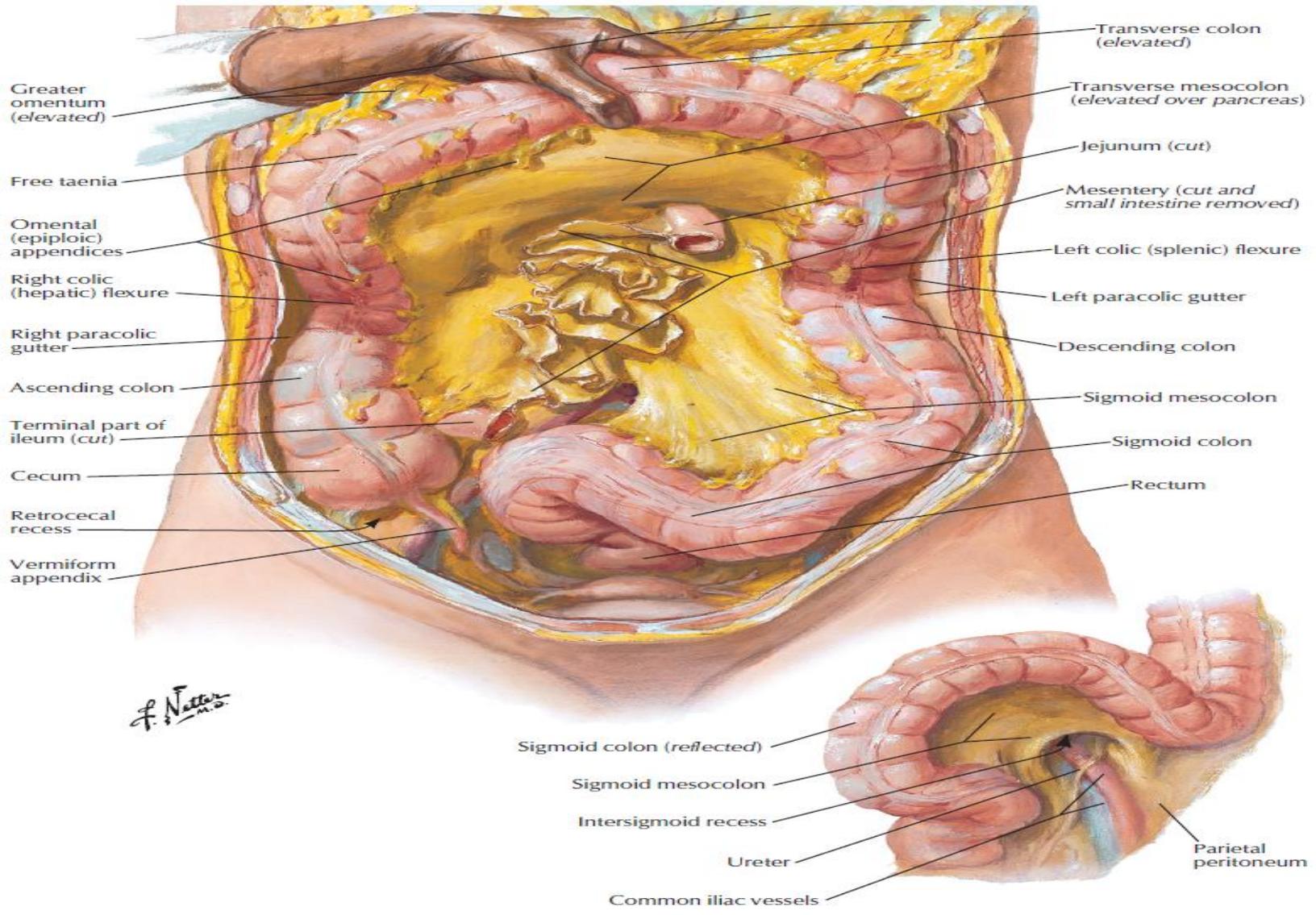




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Mesenteric Relations of Intestines (continued)

See also



Small Intestine

Stomach

Duodenum

Jejunum

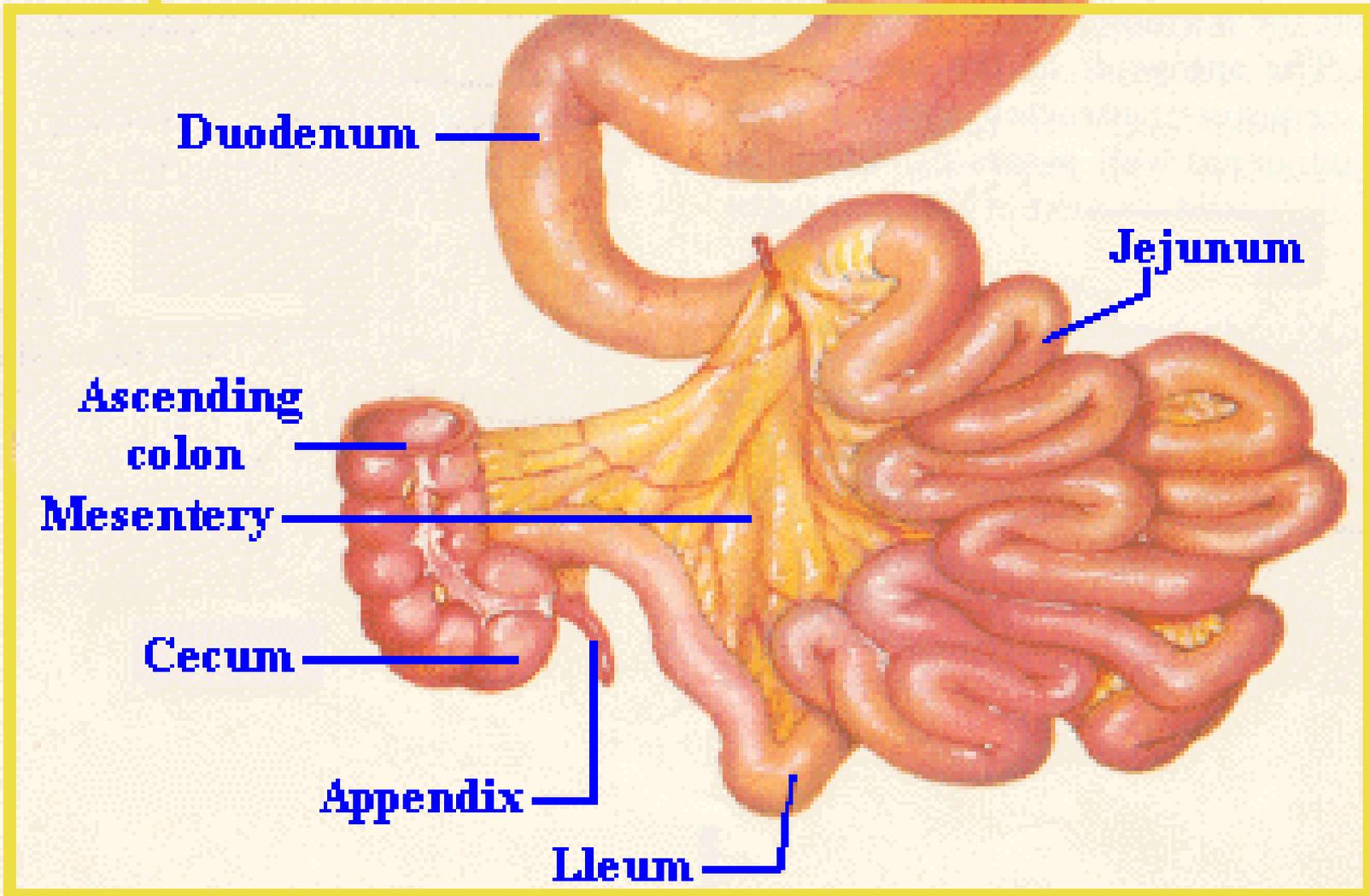
Ascending
colon

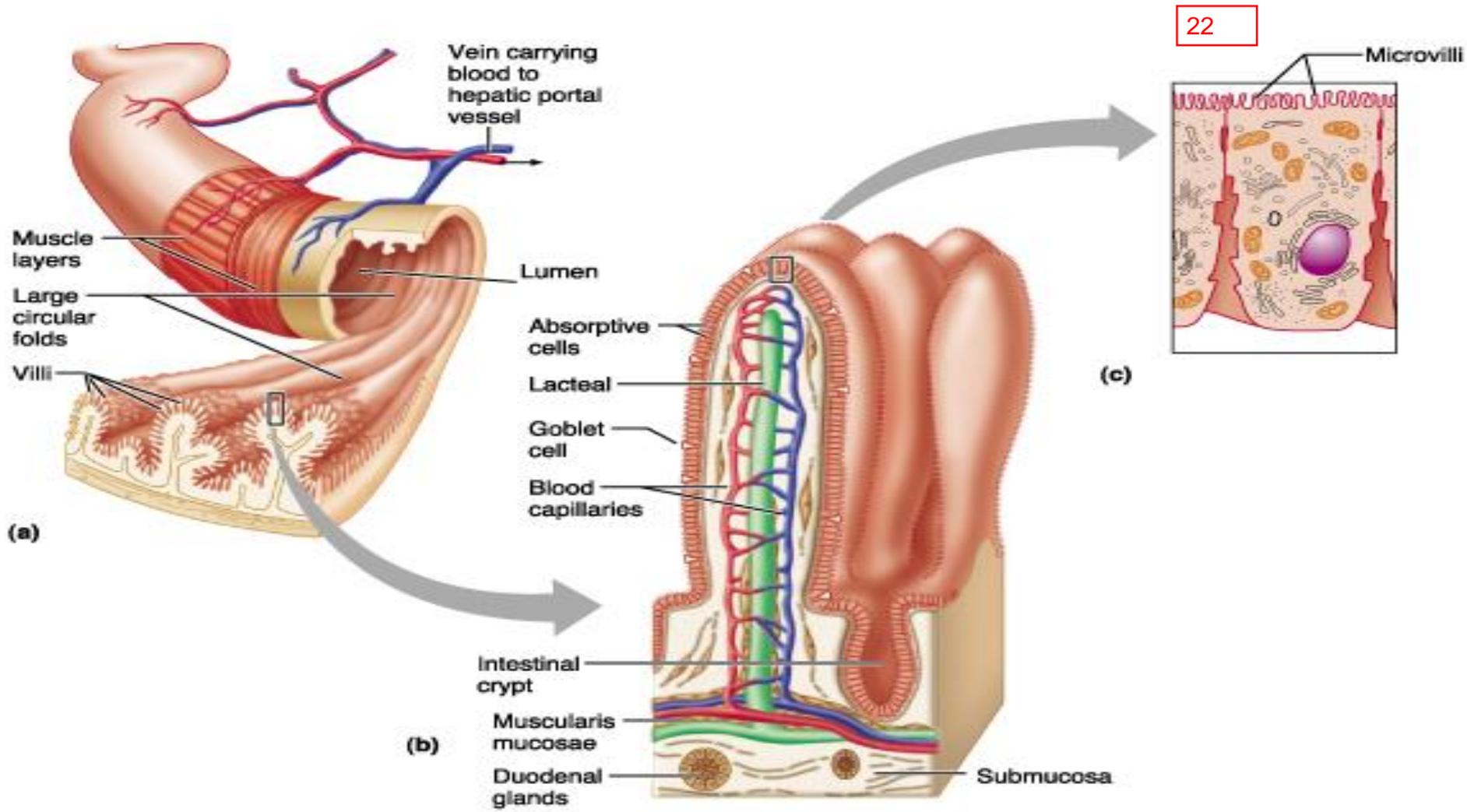
Mesentery

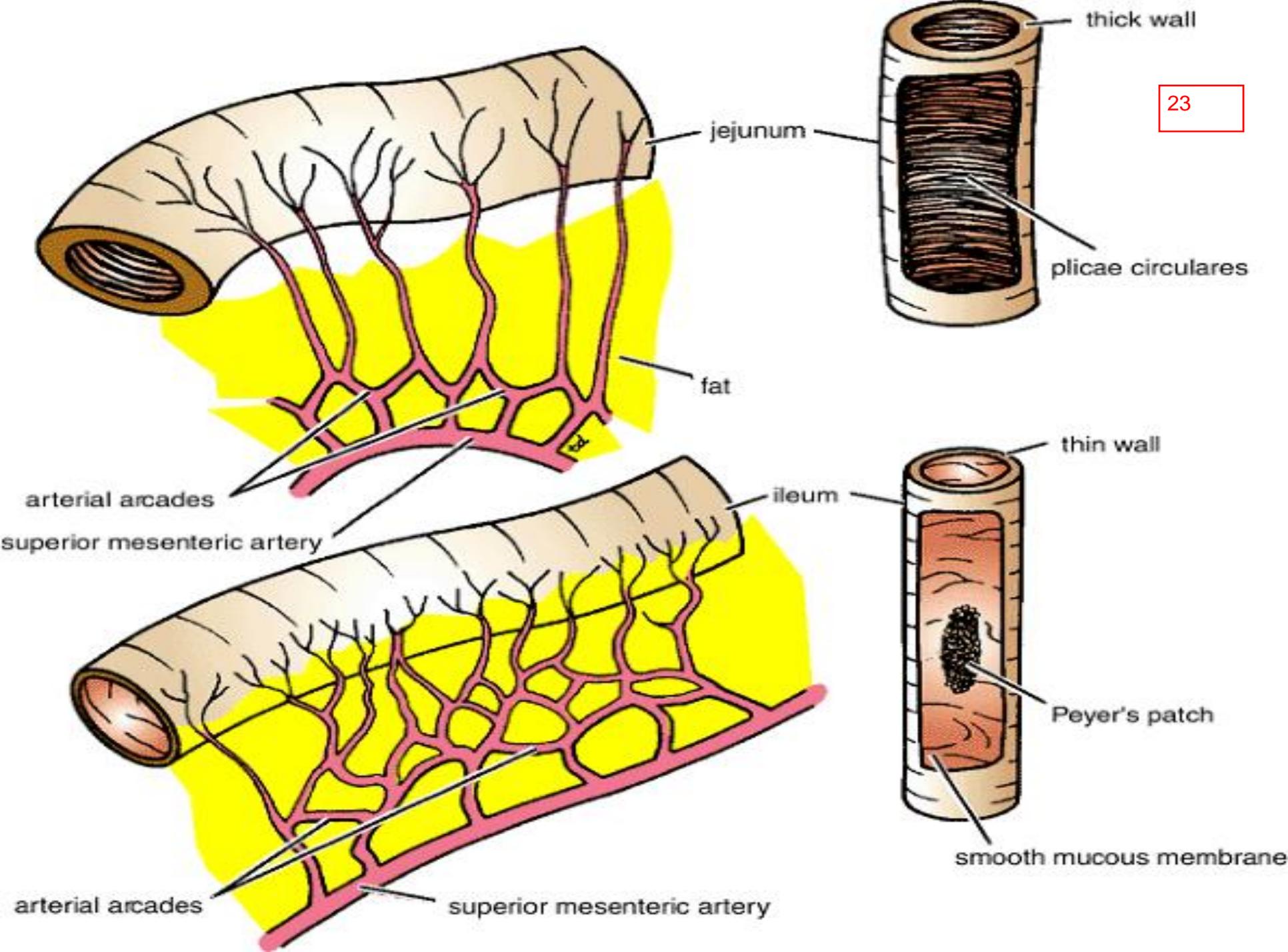
Cecum

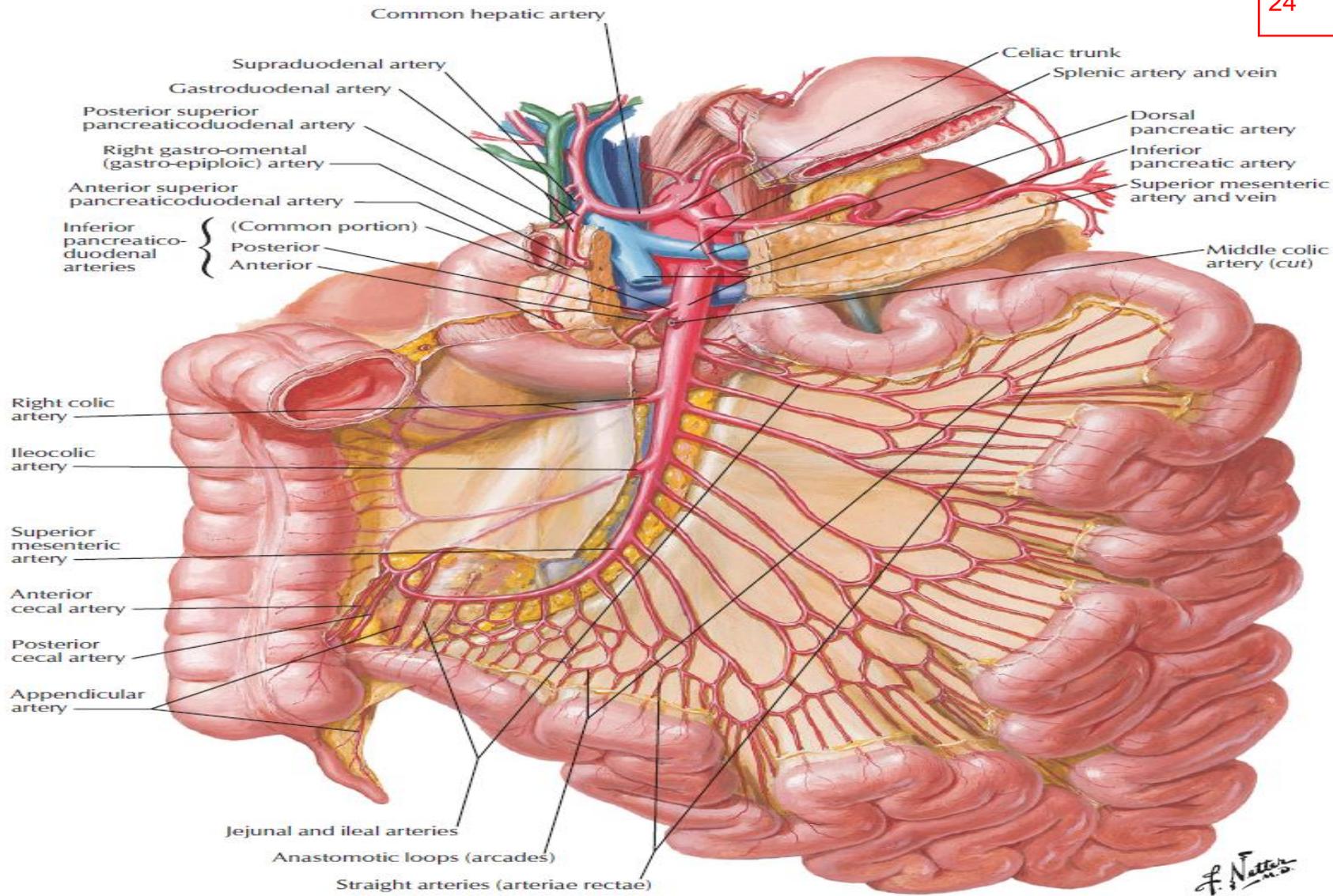
Appendix

Ileum

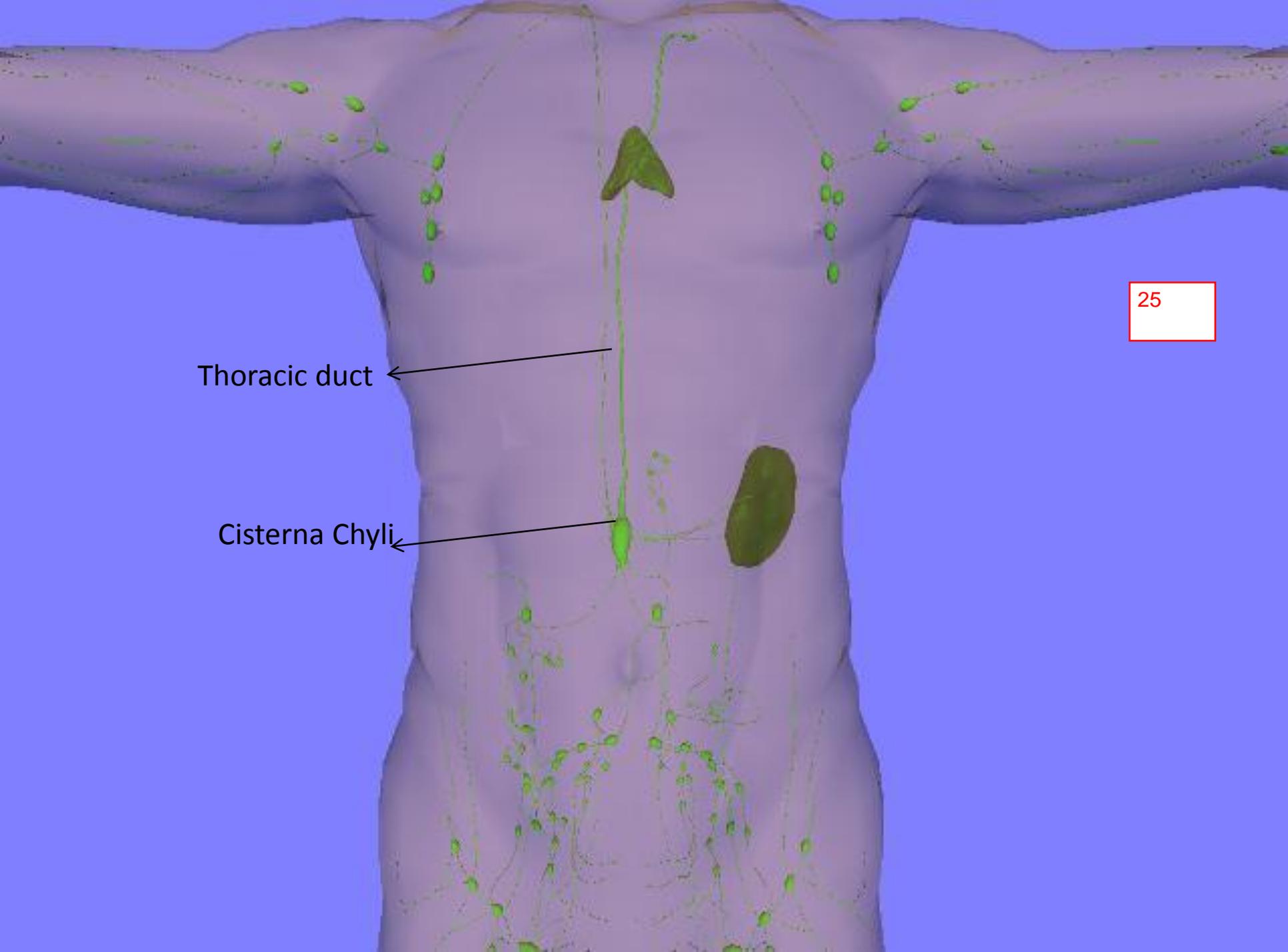






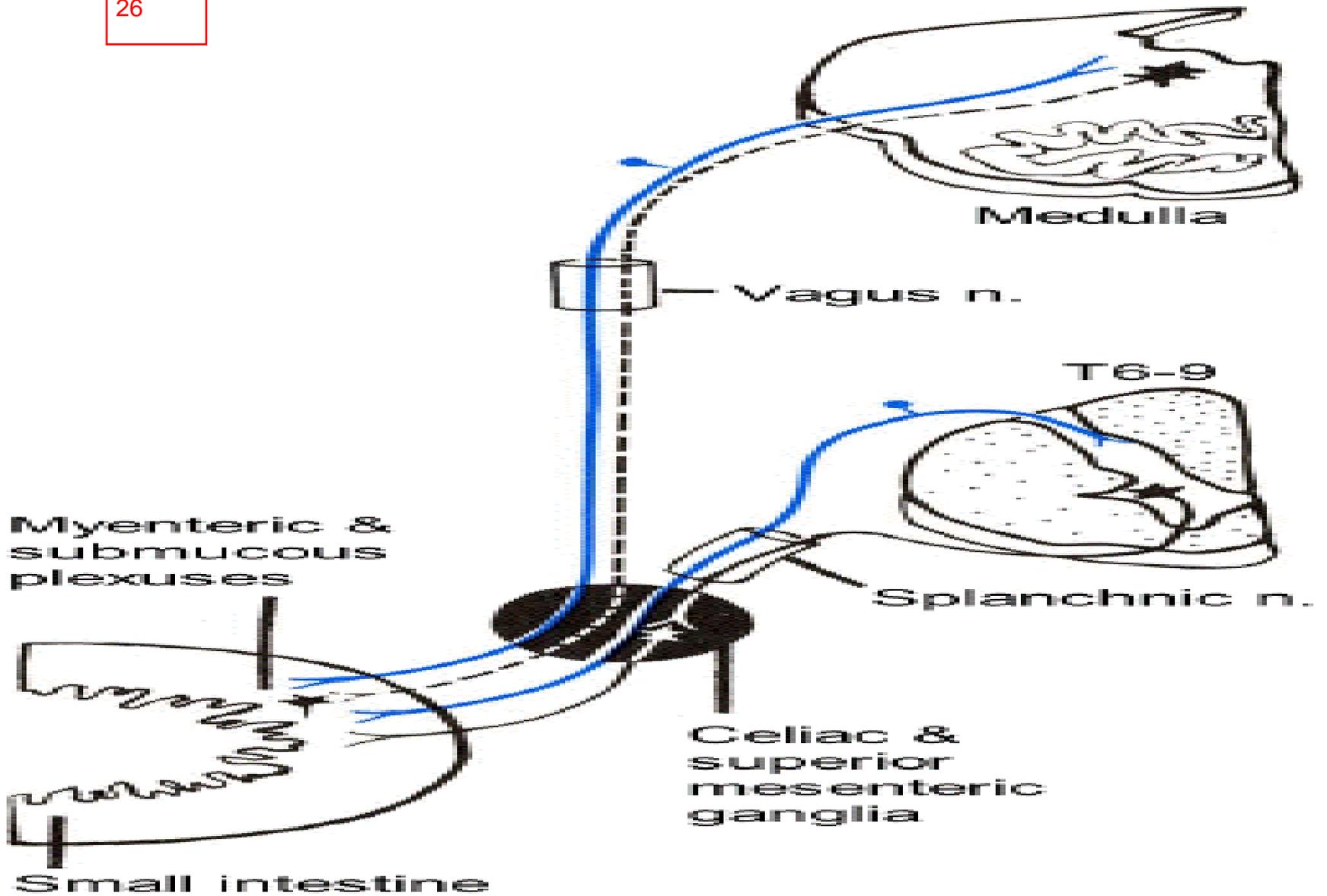


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Thoracic duct

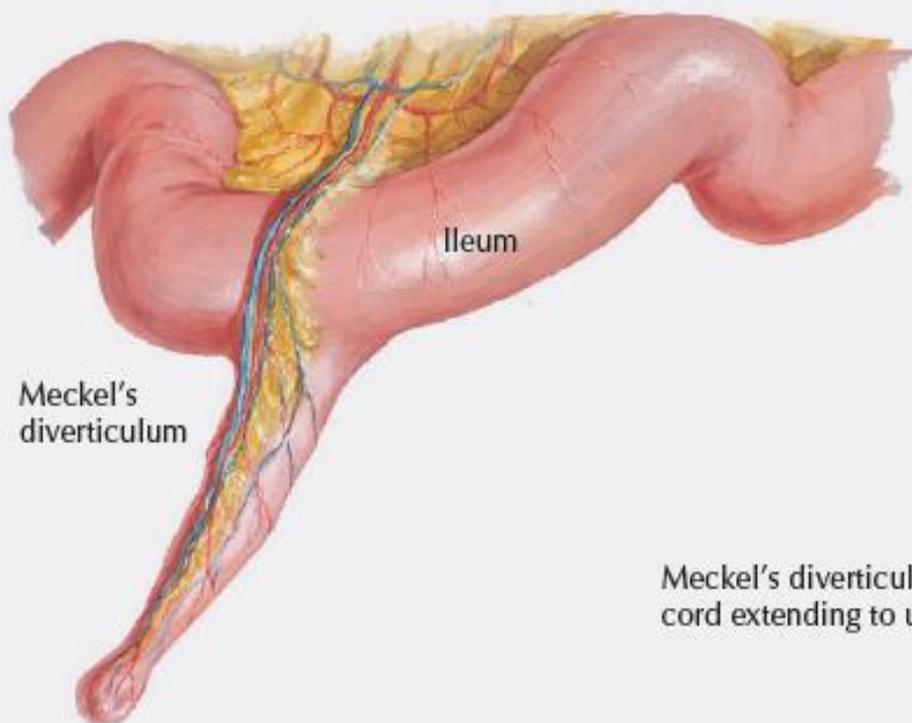
Cisterna Chyli



Meckel's Diverticulum

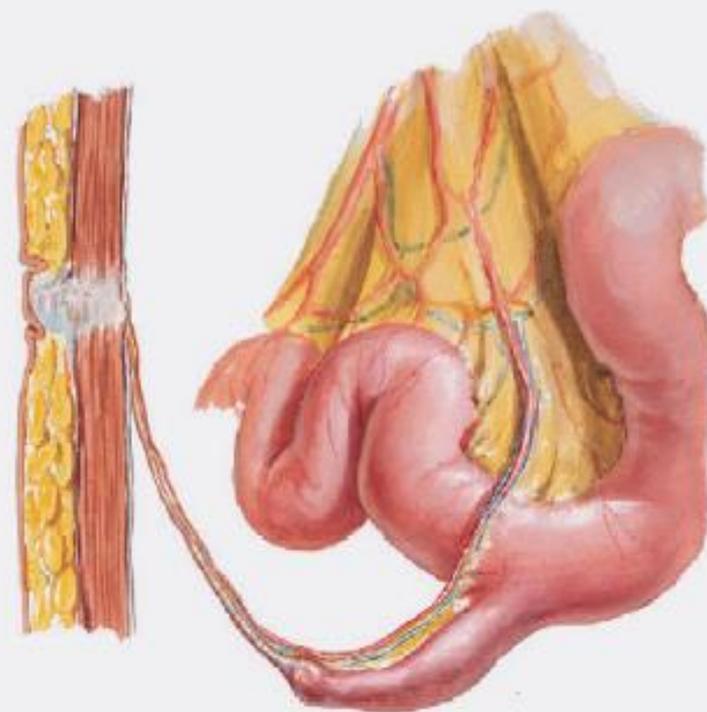
Meckel's diverticulum is the most common developmental anomaly of the bowel and results from failure of the vitelline (yolk stalk) duct to involute once the gut loop has reentered the abdominal cavity. It is often referred to as the "syndrome of twos" for the following reasons:

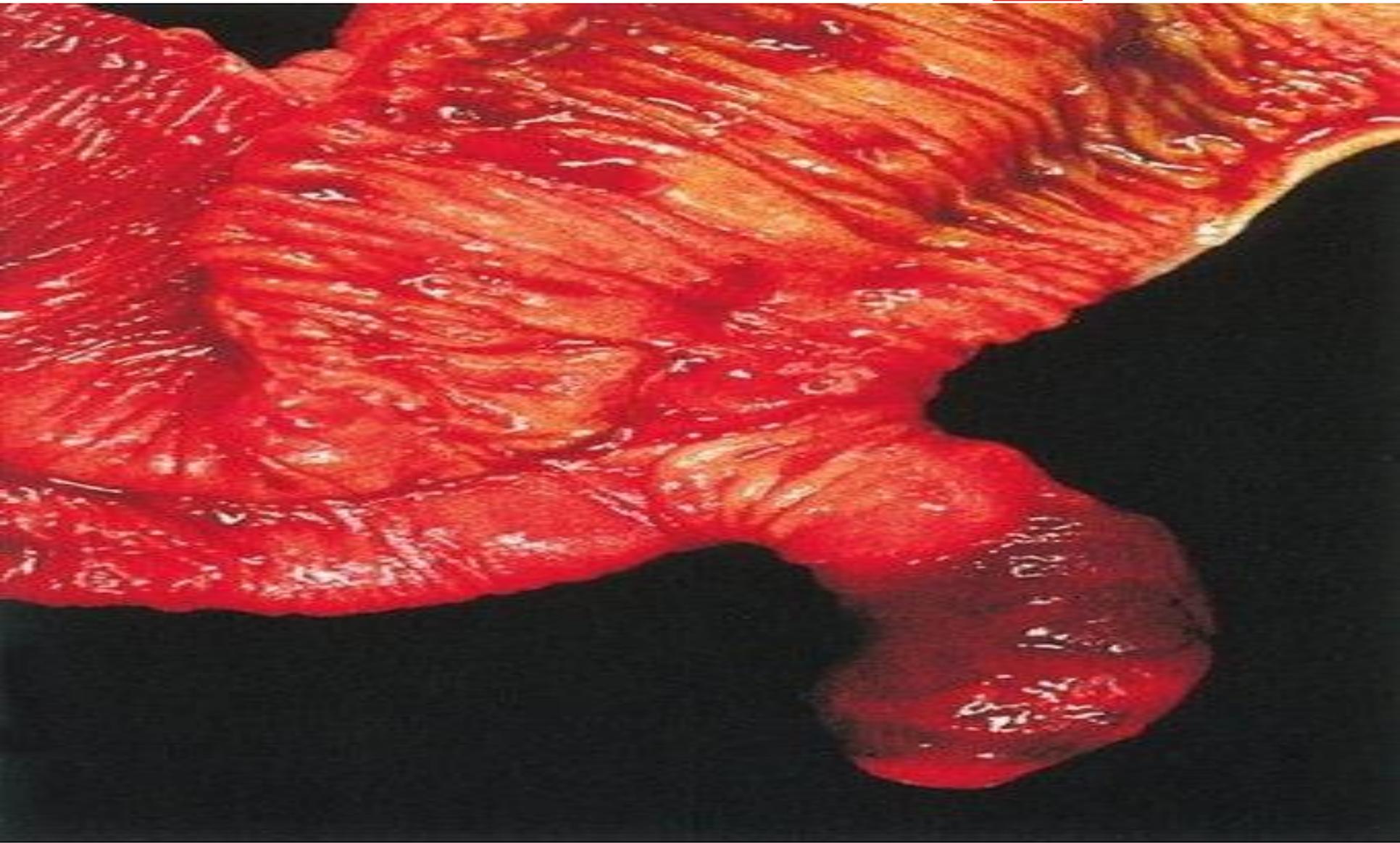
- It occurs in approximately 2% of the population.
- It is about 2 inches (5 cm) long.
- It is located about 2 feet from the ileocecal junction.
- It often contains at least two types of mucosa.



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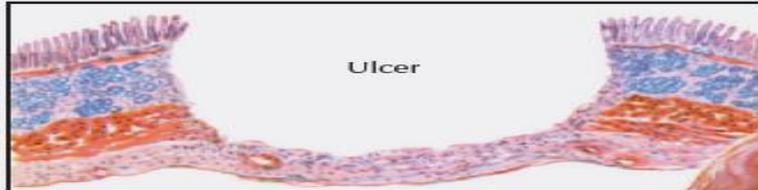
Meckel's diverticulum with fibrous cord extending to umbilicus





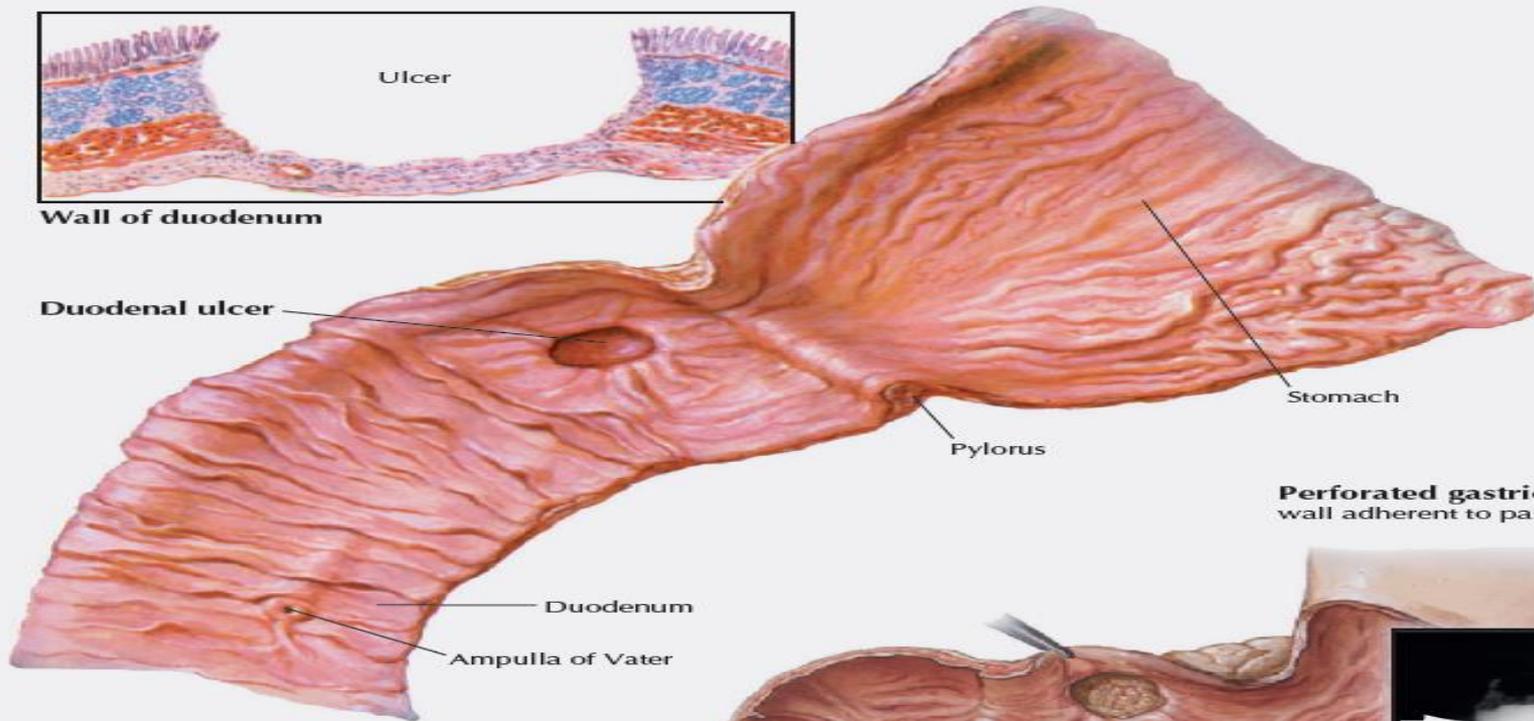
Peptic Ulcer Disease

Peptic ulcers are GI lesions that extend through the muscularis mucosae and are remitting, relapsing lesions. (*Erosions*, on the other hand, affect only the superficial epithelium.) Acute lesions are small and shallow, whereas chronic ulcers may erode into the muscularis externa or perforate the serosa. Although they may occur in the stomach, most occur in the first part of the duodenum, which is referred to by clinicians as the *duodenal cap*.

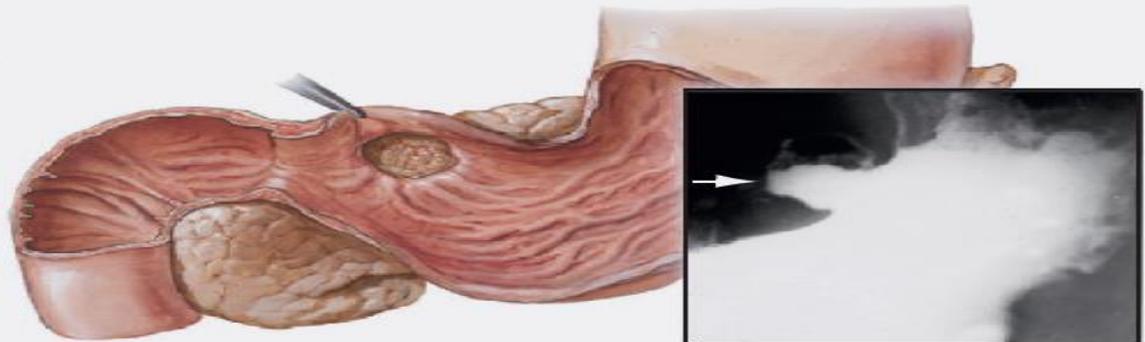


Ulcer

Wall of duodenum



Perforated gastric ulcer with wall adherent to pancreas



Barium contrast image of perforated ulcer

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Characteristics of Peptic Ulcers	
Characteristic	Description
Site	98% in first part of duodenum or stomach, in ratio of approximately 4:1
Prevalence	Worldwide approximately 5%; in United States approximately 2% in males and 1.5% in females
Age	Young adults, increasing with age
Aggravating factors	Mucosal exposure to gastric acid and pepsin; <i>H. pylori</i> infection (almost 80% of duodenal ulcers and 70% of gastric ulcers); use of nonsteroidal antiinflammatory drugs, aspirin, or alcohol; smoking