ANATOMY OF THE PANCREAS

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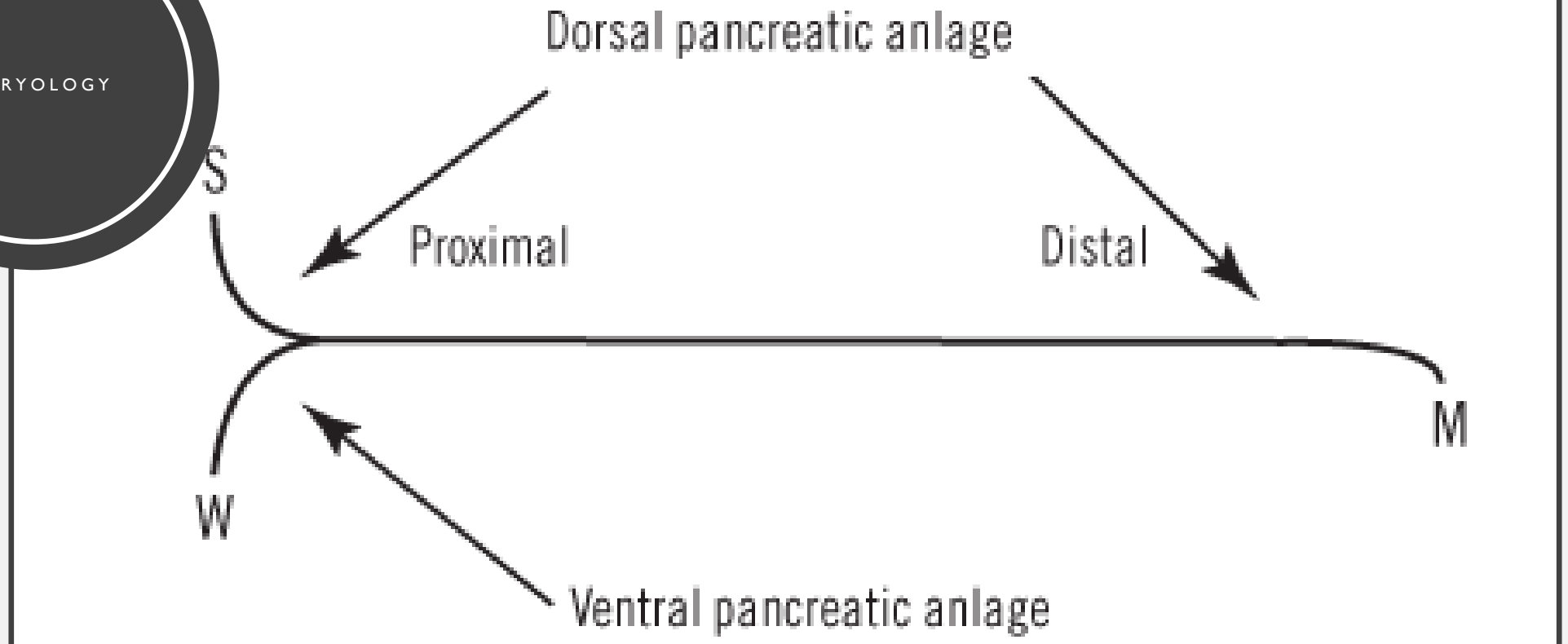
EMBRYOLOGY



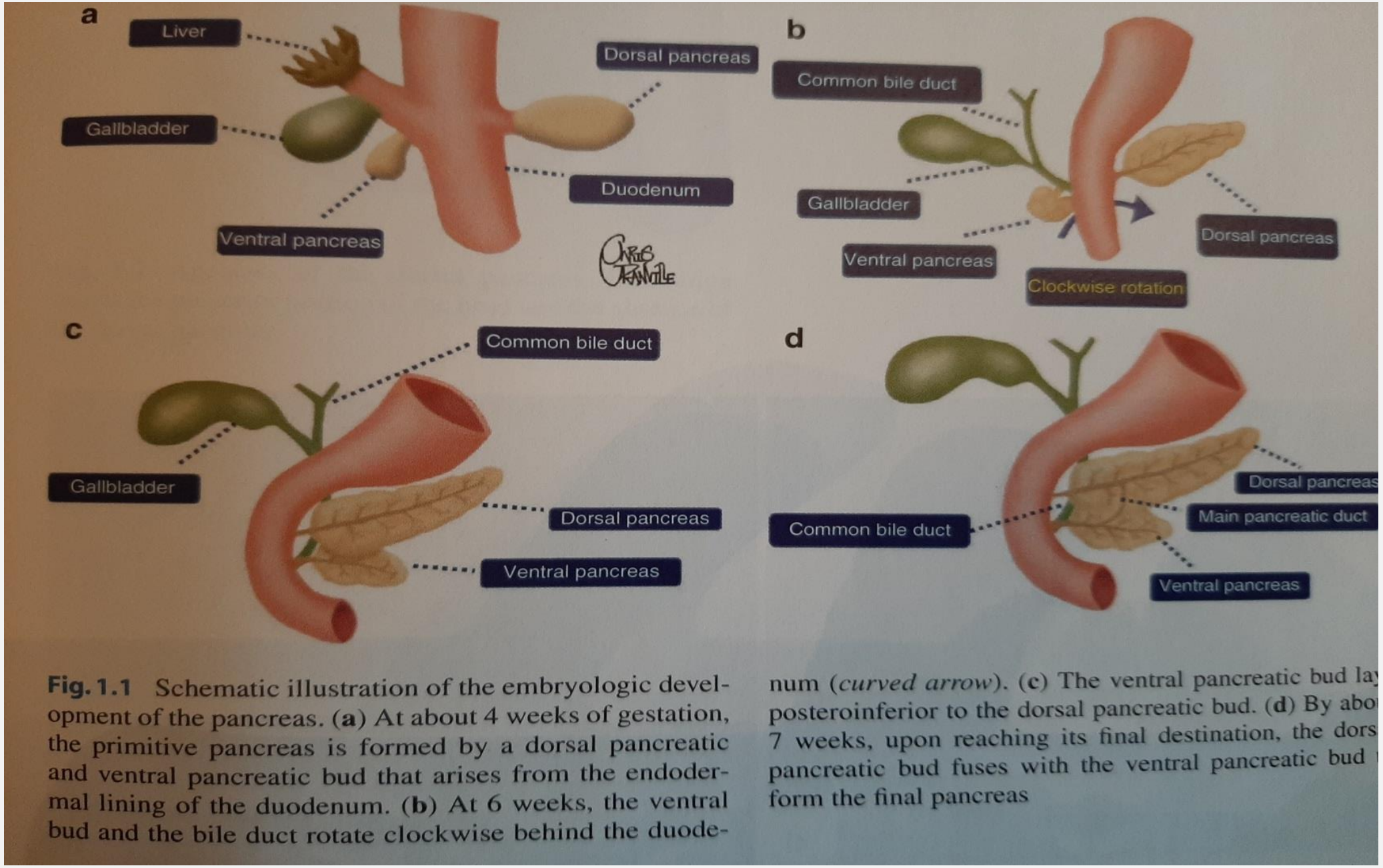
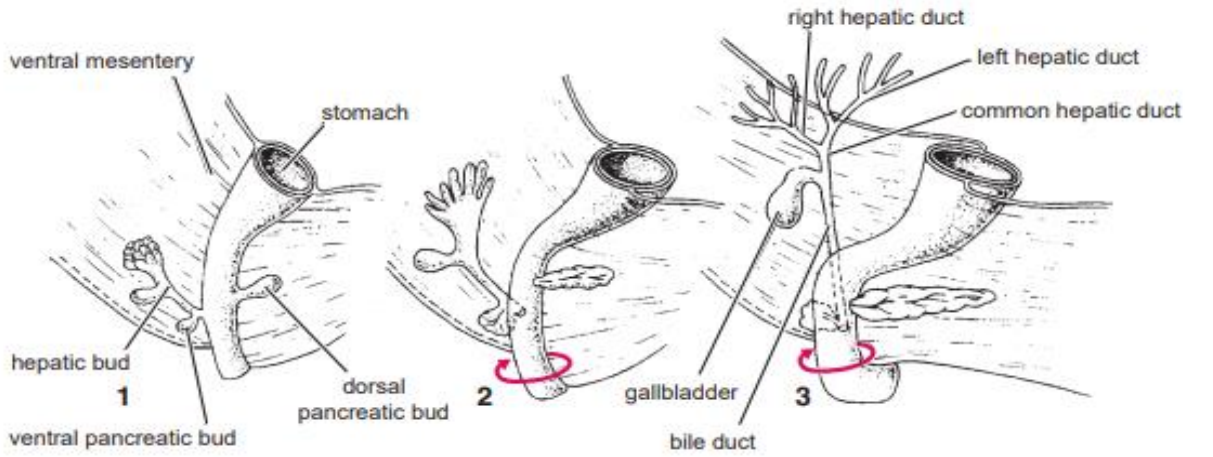


Fig. 1.1 Schematic illustration of the embryologic development of the pancreas. (**a**) At about 4 weeks of gestation, the primitive pancreas is formed by a dorsal pancreatic and ventral pancreatic bud that arises from the endodermal lining of the duodenum. (**b**) At 6 weeks, the ventral bud and the bile duct rotate clockwise behind the duodenum (*curved arrow*). (**c**) The ventral pancreatic bud lay posteroinferior to the dorsal pancreatic bud. (**d**) By abou 7 weeks, upon reaching its final destination, the dorsa pancreatic bud fuses with the ventral pancreatic bud t form the final pancreas



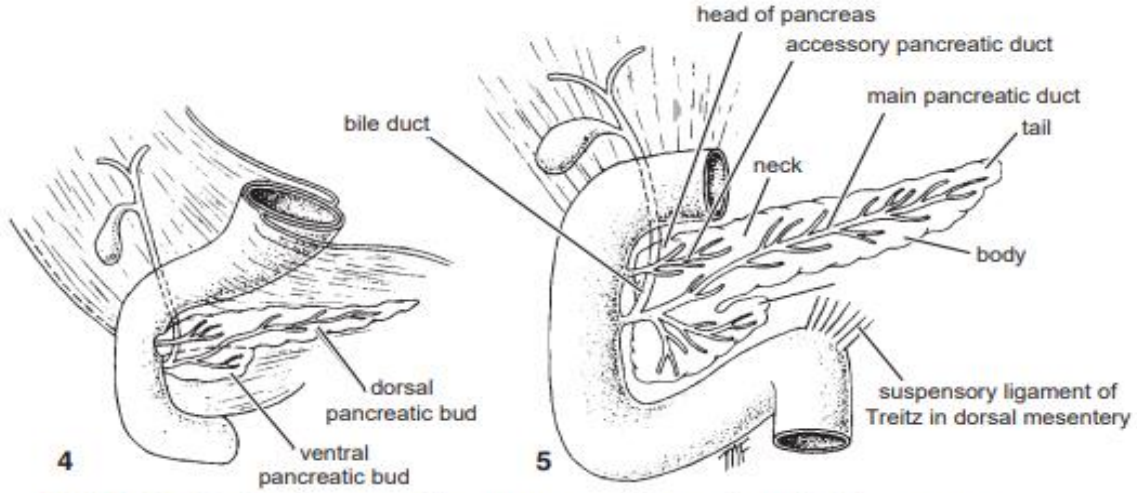


FIGURE 5.41 The development of the pancreas and the extrahepatic biliary apparatus.

NORMAL DEVELOPMENT

- Two pancreatic primordia (anlagen), the dorsal and ventral (Fig. 21-1), are responsible for the genesis of the pancreas. At the end of the fourth week, on the 26th day, the dorsal pancreatic primordium arises from the dorsal side of the duodenum. The ventral primordium arises somewhat later, on the 32nd day, from the base of the hepatic diverticulum, near the bile duct. Contact between the two pancreatic primordia takes place at about 37 days. Their fusion occurs at the end of the sixth week, the ventral primordium locating below and behind the dorsal. The ventral primordium differentiates into part of the head and uncinate process of the pancreas.

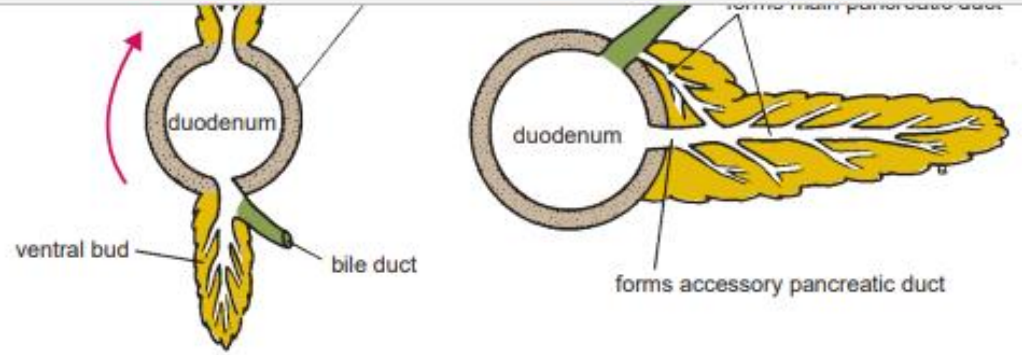


FIGURE 5.59 The rotation of the duodenum and the unequal growth of the duodenal wall lead to the fusing of the ventral and dorsal pancreatic buds.

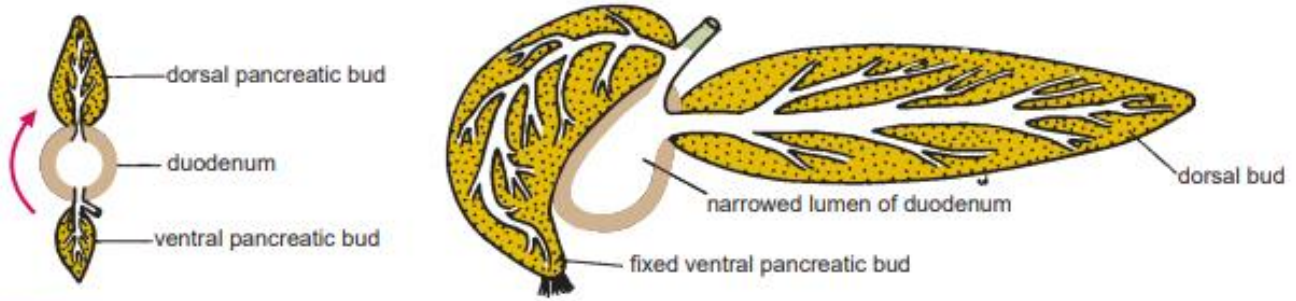
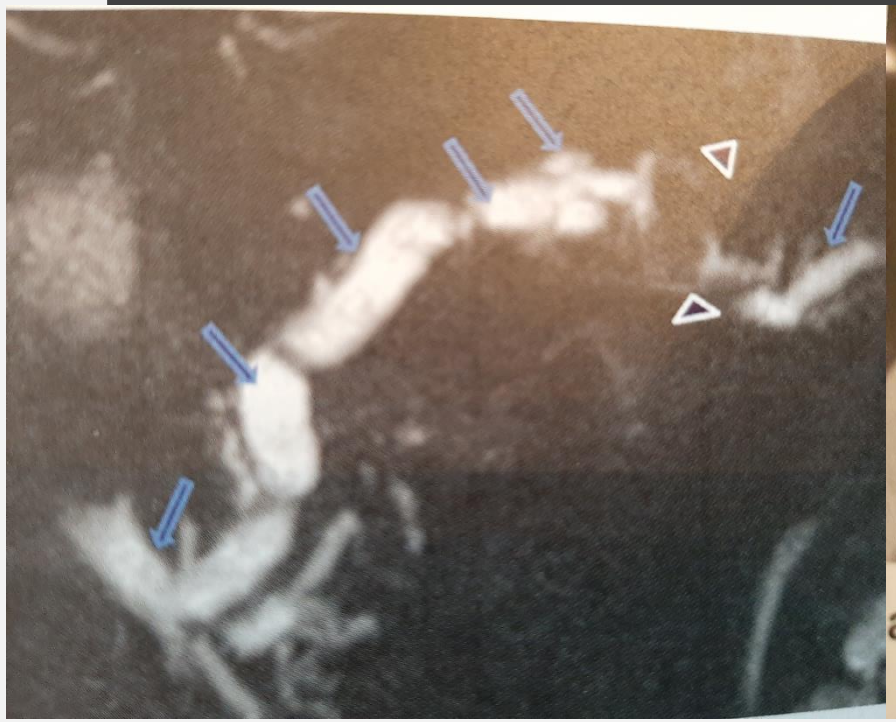


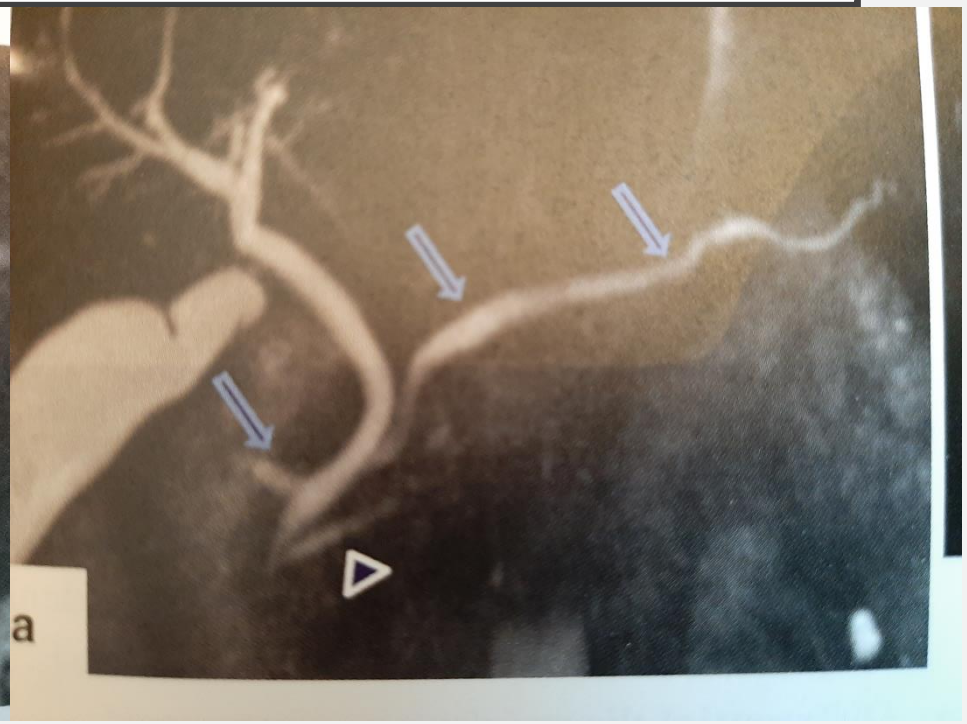
FIGURE 5.60 Formation of the anular pancreas, producing duodenal obstruction. Note the narrowing of the duodenum.

PANCREAS DIVISUM

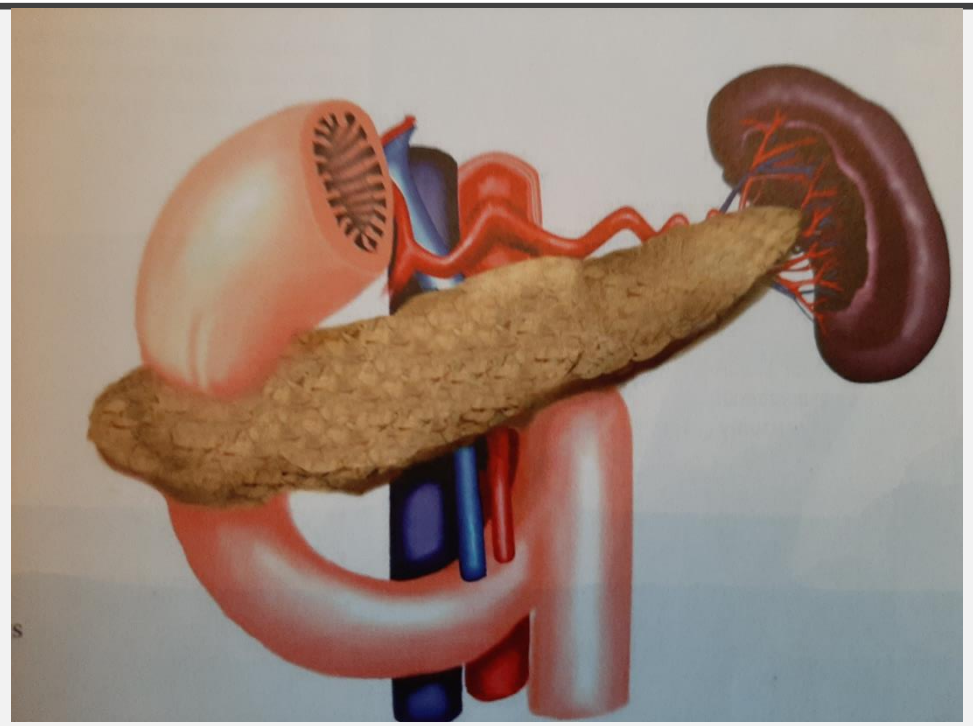
- Failure of the dorsal and ventral pancreatic primordia (anlagen) to fuse may result in separate draining of the ducts of Wirsung and Santorini. This condition is called "pancreas divisum" or "isolated ventral pancreas." About 12 percent of patients with pancreatitis have pancreas divisum demonstrated on ERCP (endoscopic retrograde cholangiopancreatography), but only 3 percent of patients who have pancreatography for other reasons have the anomaly. This suggests that pancreas divisum predisposes to attacks of acute pancreatitis.7-10 Pancreatitis may occur secondary to stenosis or obstruction of one or both ducts. Stenting may relieve the symptoms of patients with chronic pancreatitis.11,12 To avoid the formation of stones, sphincteroplasty of both ducts and cholecystectomy is the current procedure of choice. Neblett and O'Neill13 advised that patients with more distal ductal obstruction or ductal ectasia may benefit from pancreaticojejunostomy. Kamisawa et al.14 presented what may be the first report of carcinoma associated with anular pancreas coexistent with pancreas divisum.

PANCREAS DIVISUM

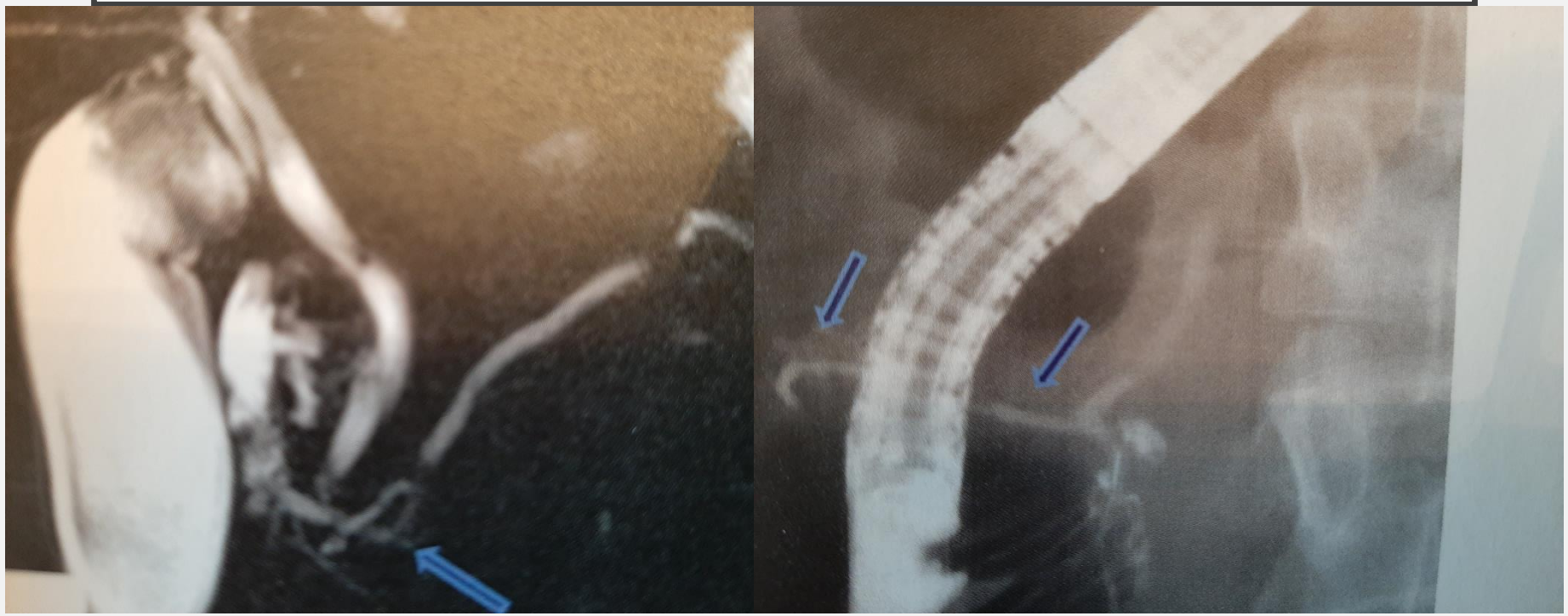




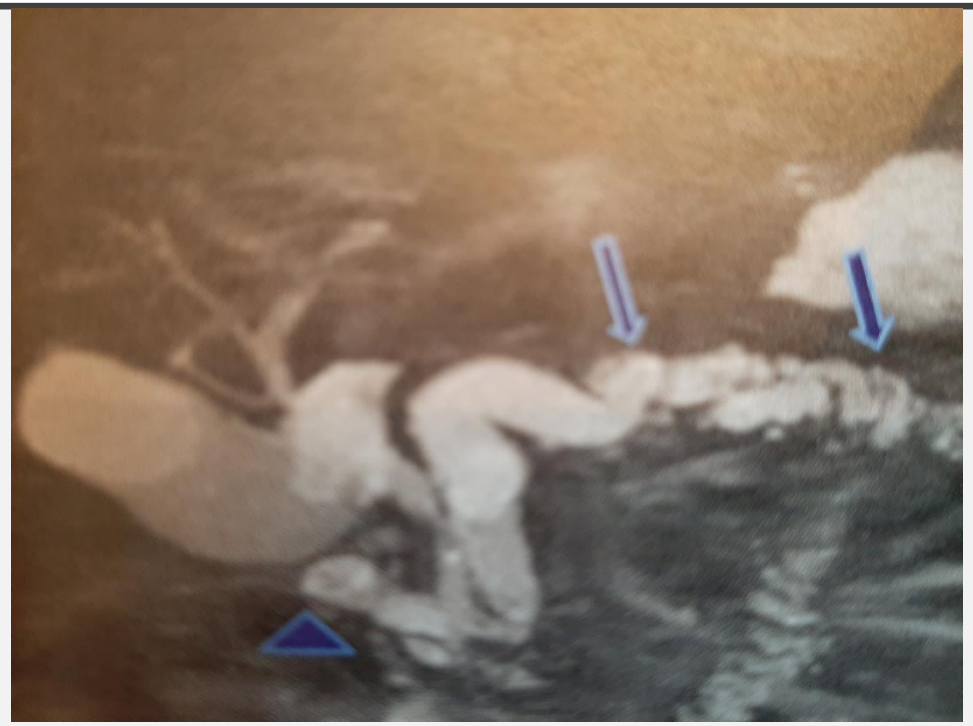
ANNULAR PANCREAS



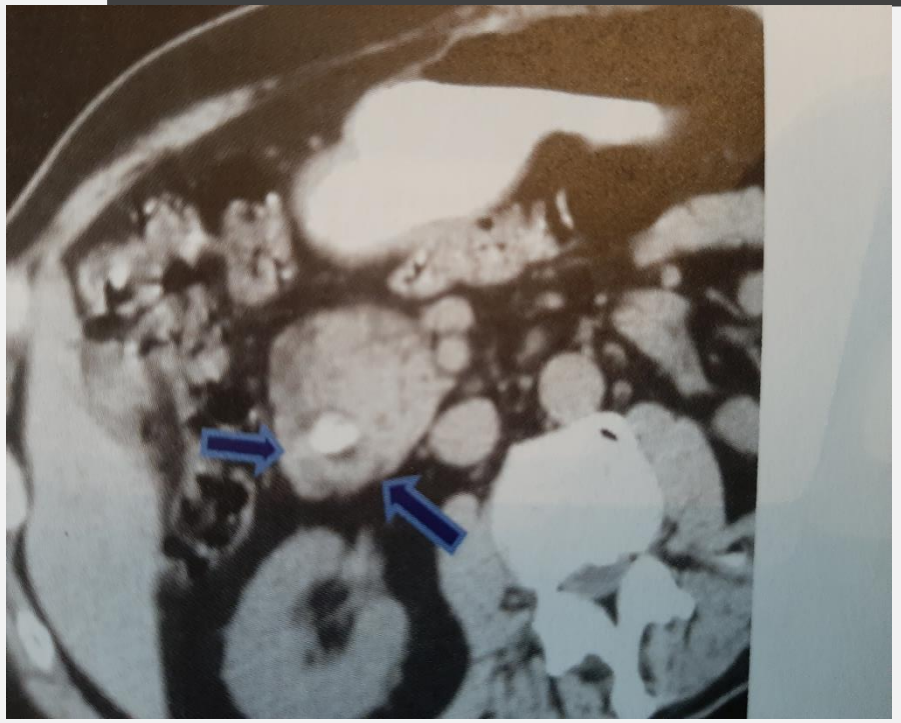
ANNULAR PANCREAS

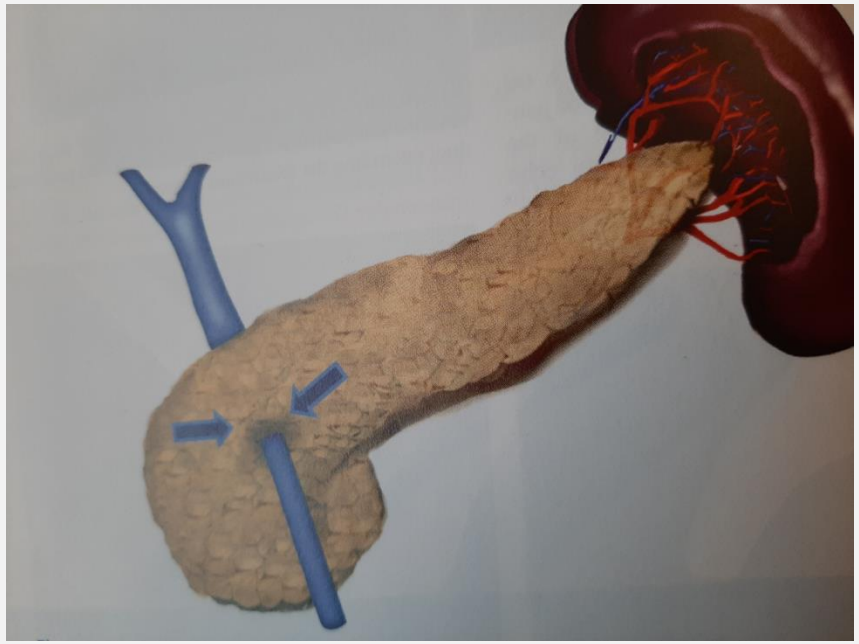


ANNULAR PANCREAS AND CP

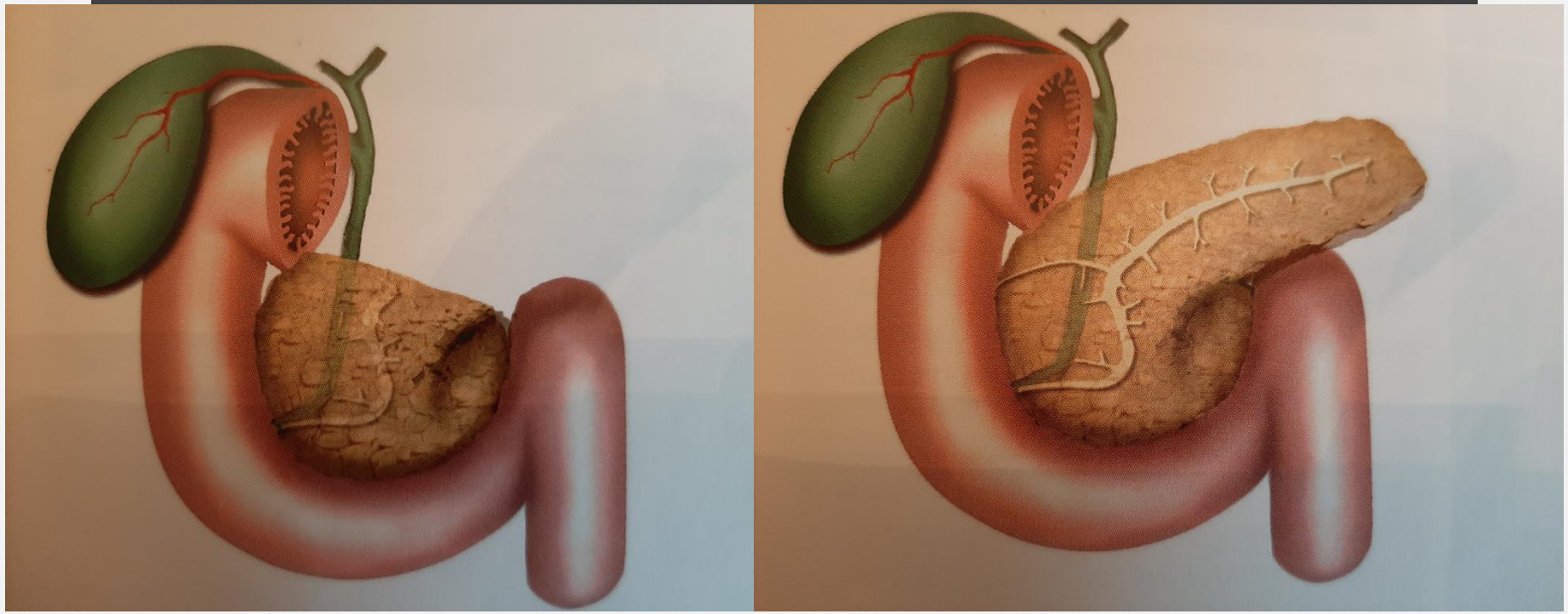


PORTAL ANNULAR PANCREAS

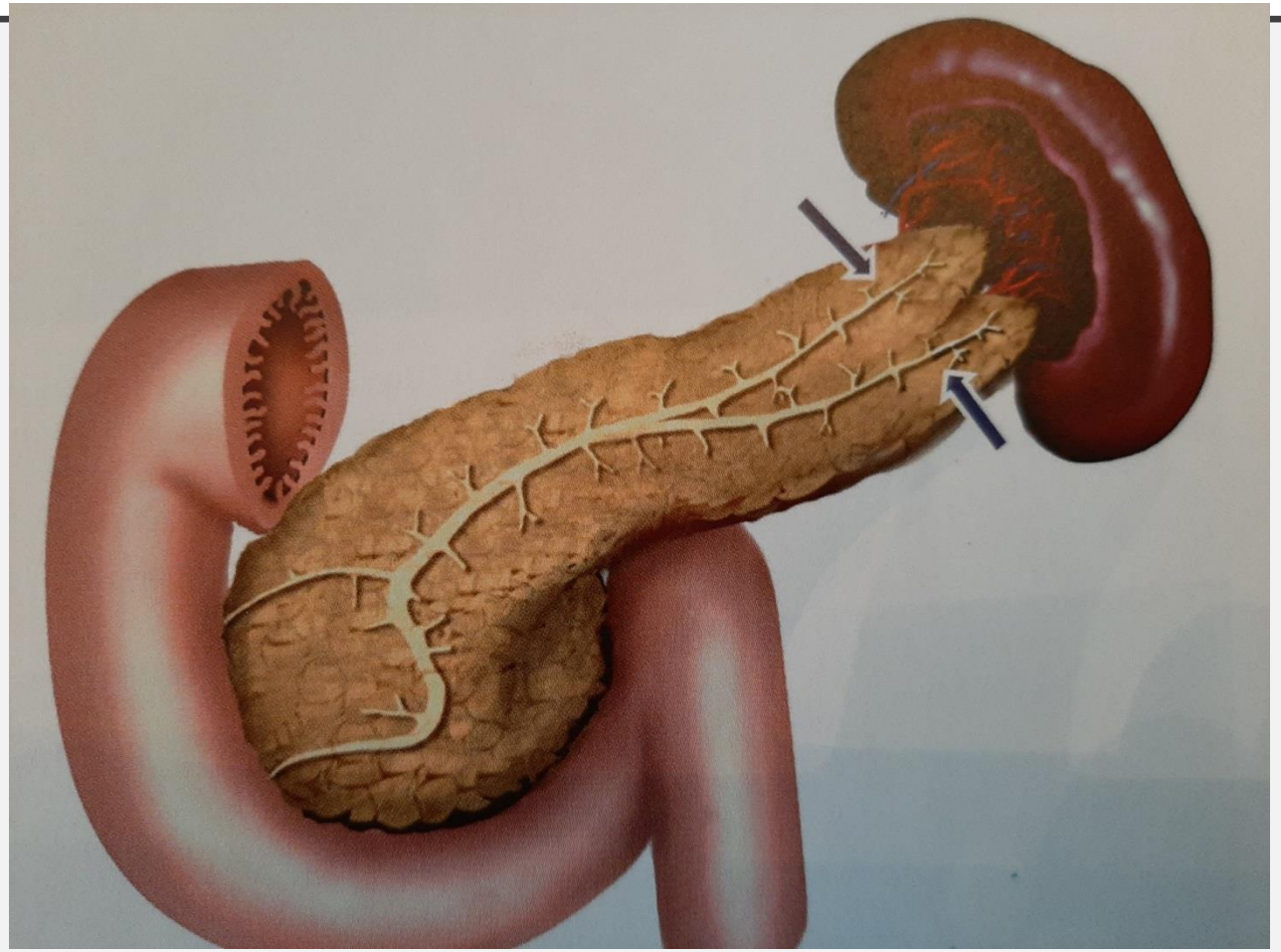




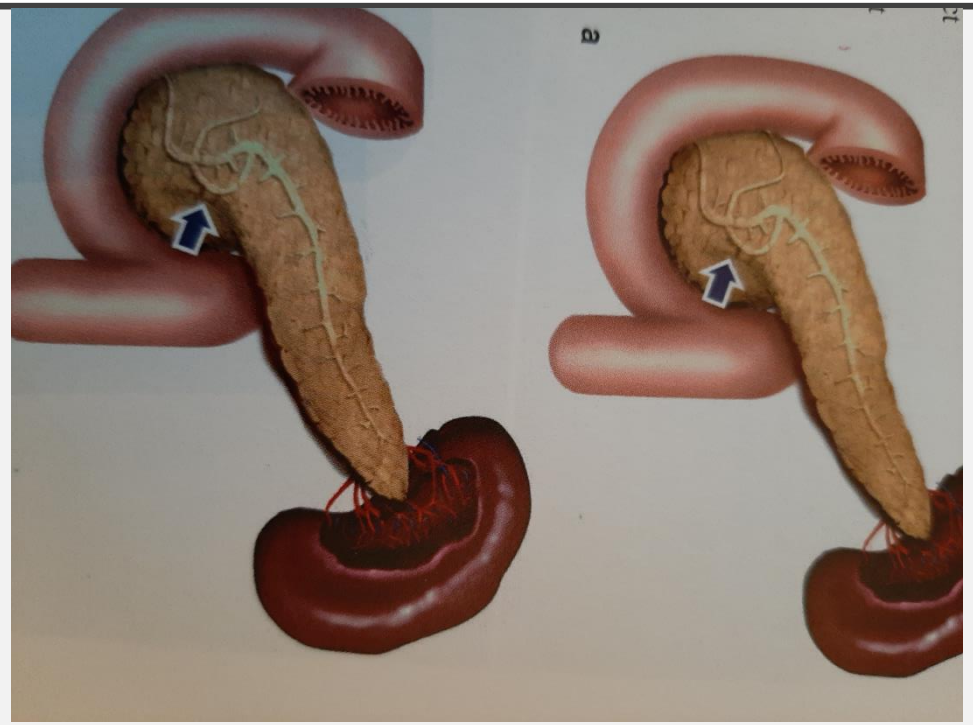
AGENESIS

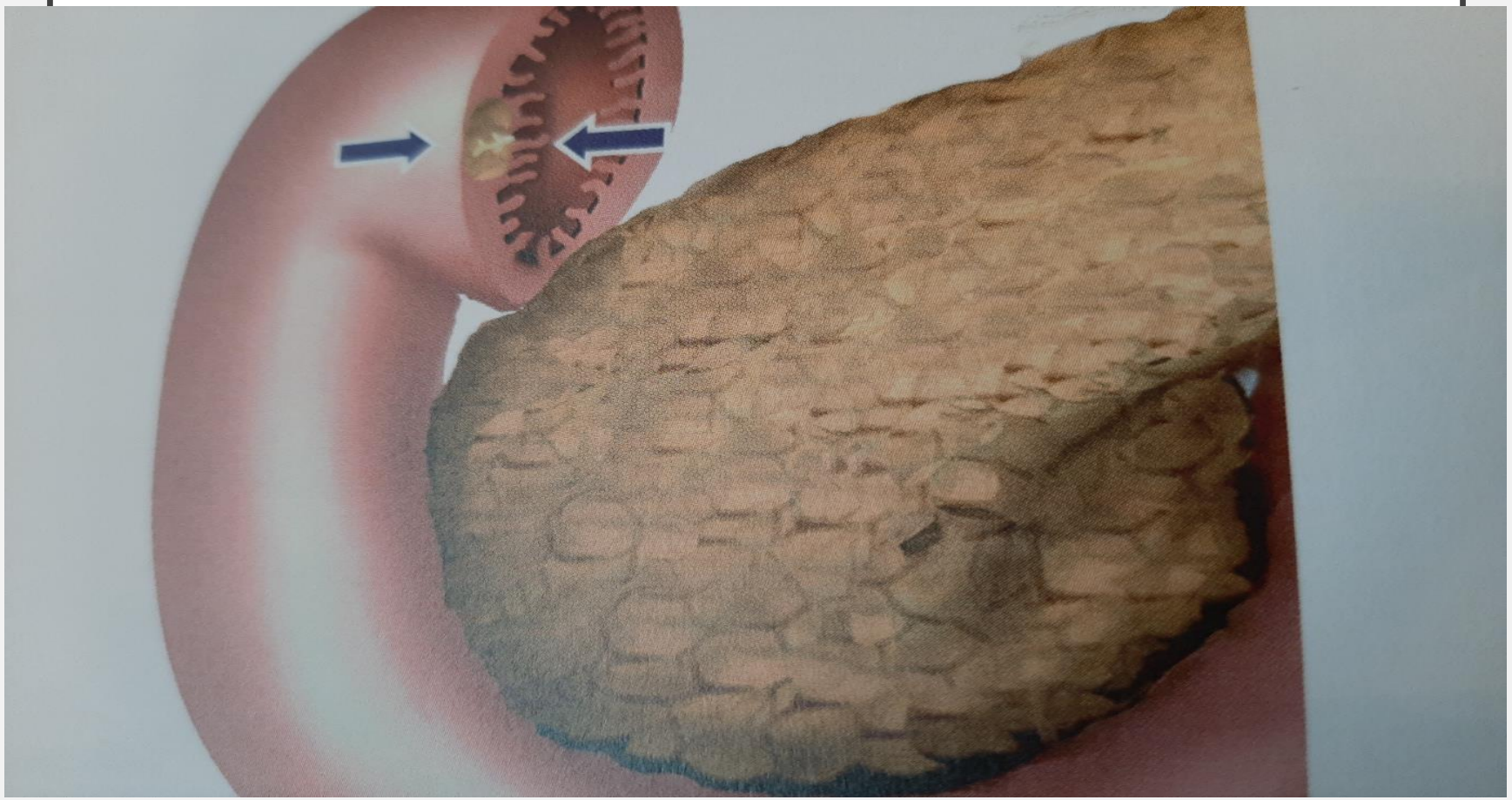


BIFID TAIL OF THE PANCREAS

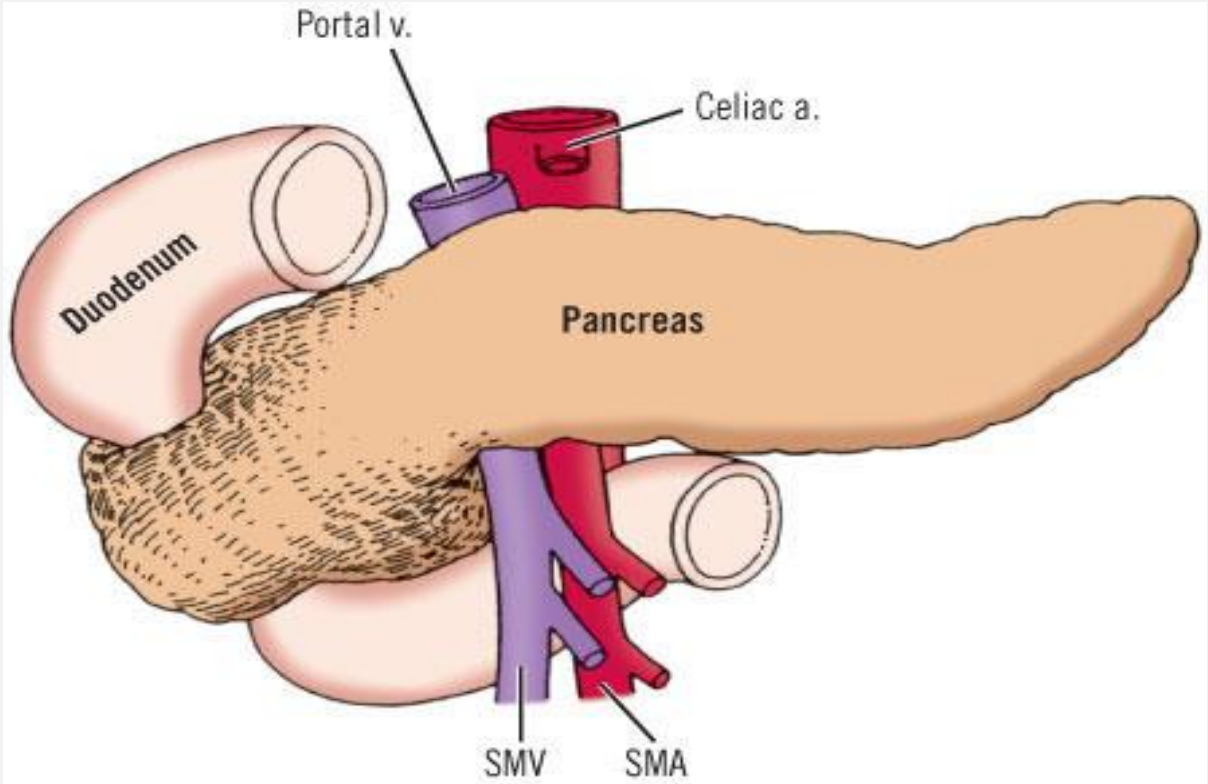


ANSA PANCREATICA

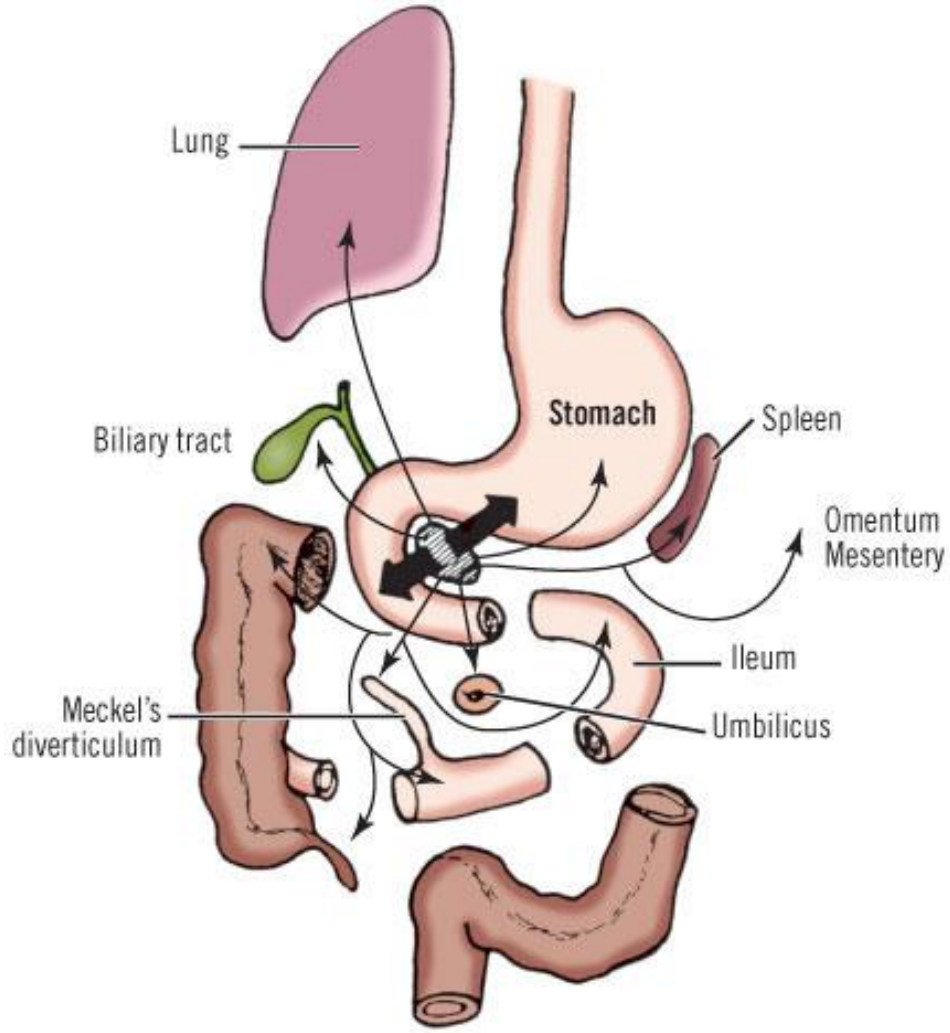




ANNULAR PANCREAS



CHIEF SITES OF HETEROTOPIC PANCREATIC TISSUE



TOPOGRAPHIC ANATOMY

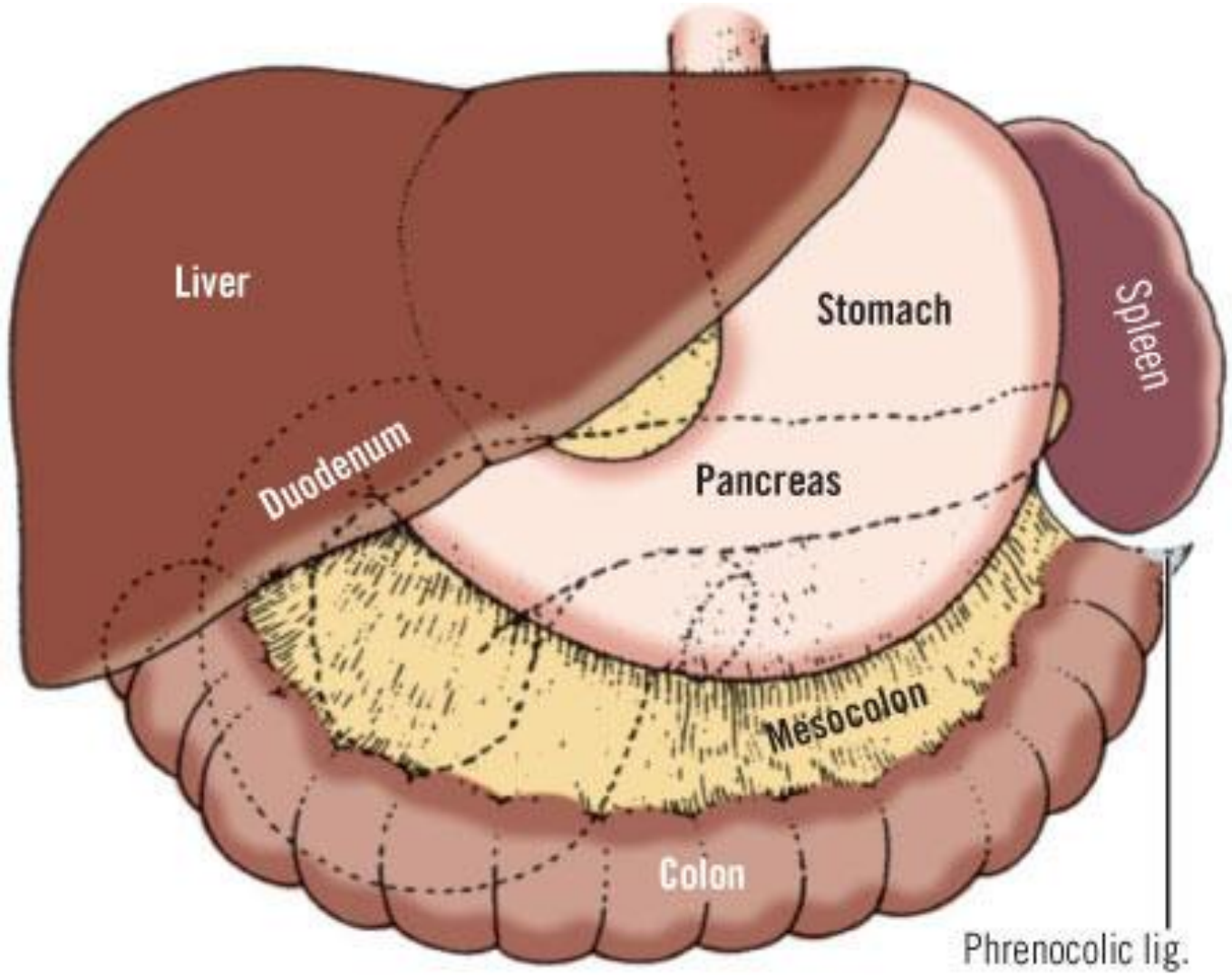
- The pancreas was covered by the peritoneum within the omental bursa except its tail. Additionally, the anterior layer of the hepatogastric ligament turned over the hepatoduodenal ligament and continued behind the head of the pancreas together with the peritoneum which formed the posterior wall of the epiploic foramen (Winslow). The peritoneum also covered a part of the posterior surface of the body and directed to the right, forming a recessus just behind the pancreas.

ANATOMICAL RELATIONS

- The pancreas is neither striking in appearance nor obvious in function. Its early history is hardly more than a list of the names of those who noticed it in their dissections before passing on to more interesting organs. It was only with demonstration of the digestive enzymes by Claude Bernard in 1850 that the pancreas became a complete organ with an important function and thus an object worthy of study.

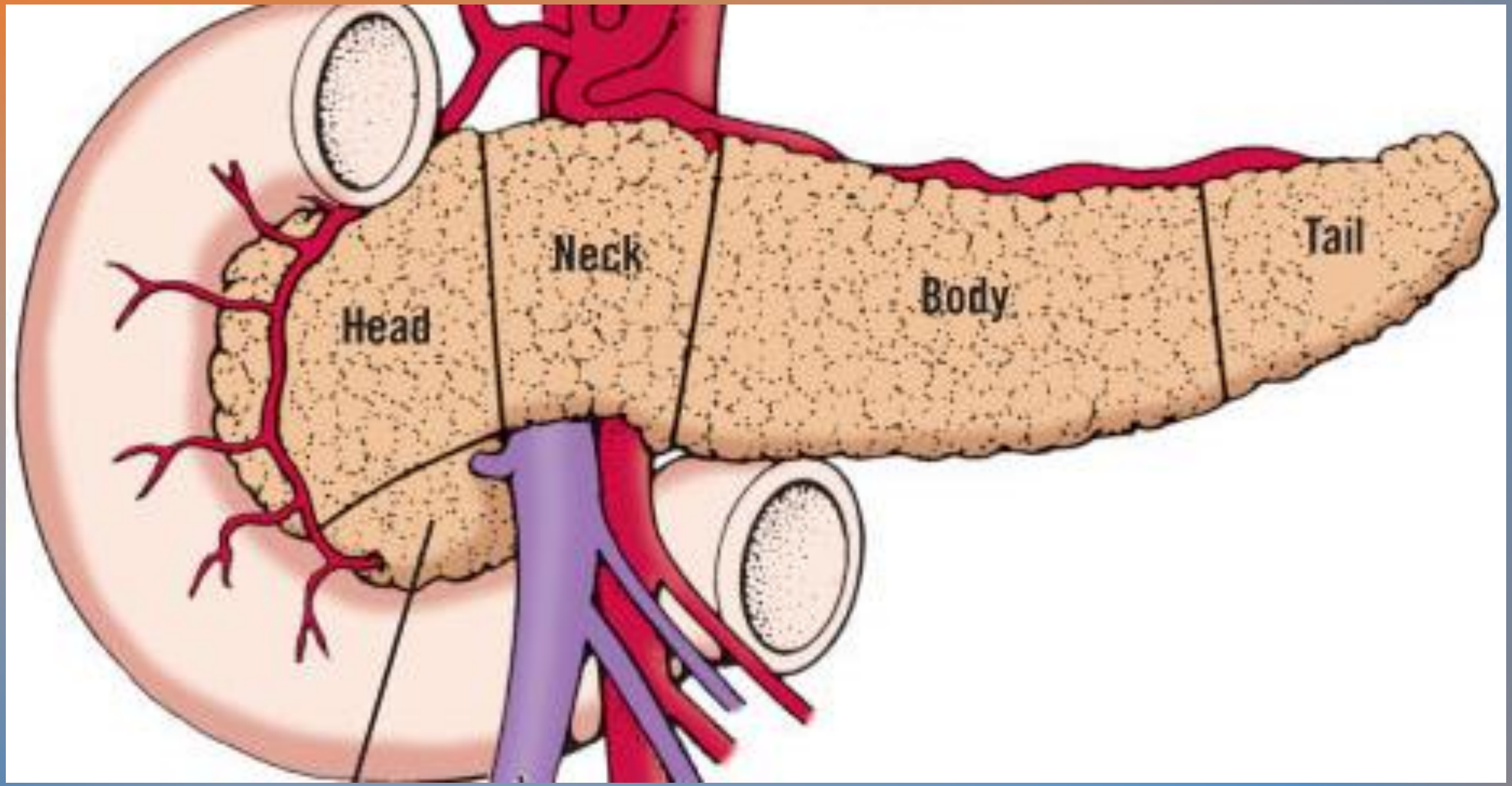
- In spite of the apparent accessibility of the pancreas, several anatomic relations combine to make its surgical removal difficult. In 1898, Halstead was the first to successfully remove the head of the pancreas and a portion of the duodenum for ampullary cancer. Several surgeons, in the United States and elsewhere, subsequently developed two-stage operations for removal of the head of the pancreas. These efforts culminated in 1940 with the one-stage operation of Allen O. Whipple. A major factor in Whipple's success was the use of silk sutures, which tend to resist digestion by enzymes that destroy catgut sutures.

- The embryogenesis of the pancreas and its deep retroperitoneal anatomy are responsible for the tiger country. No other organ is so closely surrounded by so many anatomic entities, including the duodenum, stomach, spleen, left adrenal, transverse mesocolon and colon, left kidney, right ureter, and jejunum. Figures 21-6, 21-7, 21-8, and 21-9 show anterior and posterior relations of the pancreas.

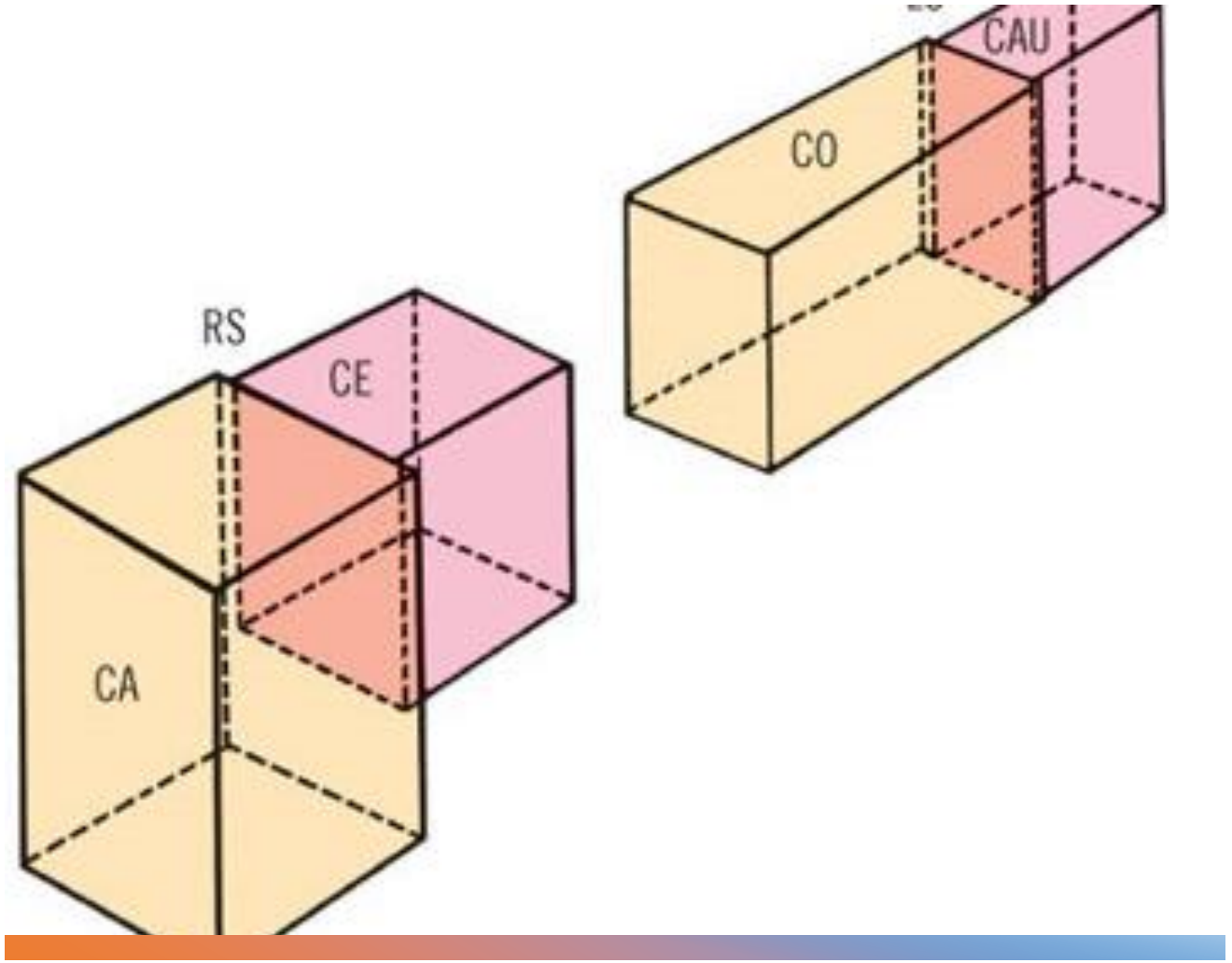


LOCATION AND DESCRIPTION I

- The pancreas is both an exocrine and endocrine gland.
- The exocrine portion of the gland produces a secretion that contains enzymes capable of hydrolyzing proteins, fats, and carbohydrates.
- The endocrine portion of the gland, the pancreatic islets (islets of Langerhans), produces the hormones insulin and glucagon.
- The pancreas is an elongated structure that lies in the epigastrium and the left upper quadrant.
- It is soft and lobulated and situated on the posterior abdominal wall behind the peritoneum. It crosses the transpyloric plane.
- The pancreas is divided into a head, neck, body, and tail.

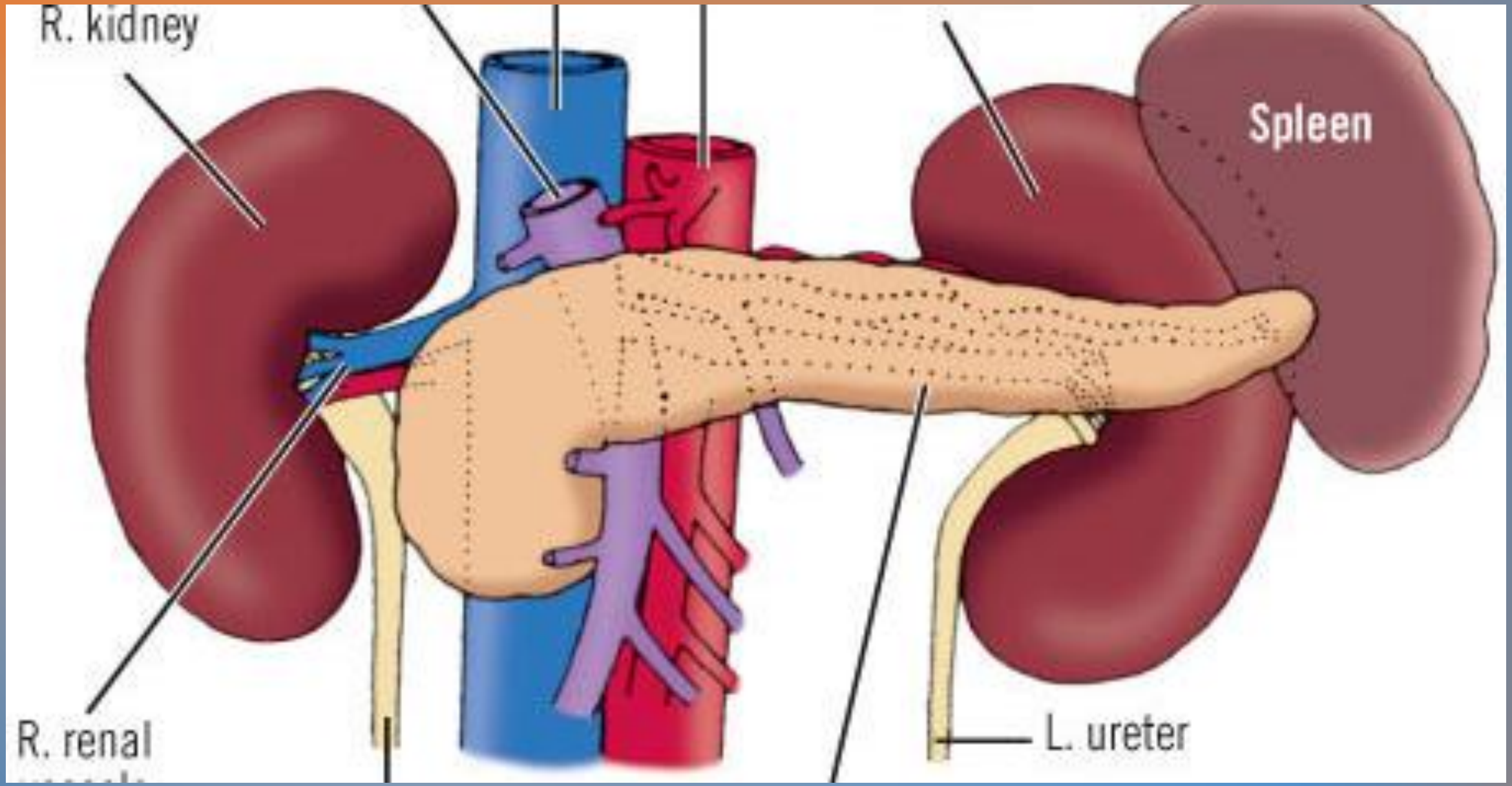

Head
Neck
Body
Tail

Diagrams of the anatomicosurgical segments of the pancreas



LOCATION AND DESCRIPTION II

- The head of the pancreas is disc shaped and lies within the concavity of the duodenum. A part of the head extends to the left behind the superior mesenteric vessels and is called the uncinate process
- The neck is the constricted portion of the pancreas and connects the head to the body.
- The body runs upward and to the left across the midline.It is somewhat triangular in cross section.
- The tail passes forward in the splenicorenal ligament and comes in contact with the hilum of the spleen.


R. kidney
Spleen
R. renal
L. ureter

RELATIONS

■ Anteriorly: From right to left: the transverse colon and the attachment of the transverse mesocolon, the lesser sac, and the stomach.

■ Posteriorly: From right to left: the bile duct, the portal and splenic veins, the inferior vena cava, the aorta, the origin of the superior mesenteric artery, the left psoas muscle, the left suprarenal gland, the left kidney, and the hilum of the spleen.

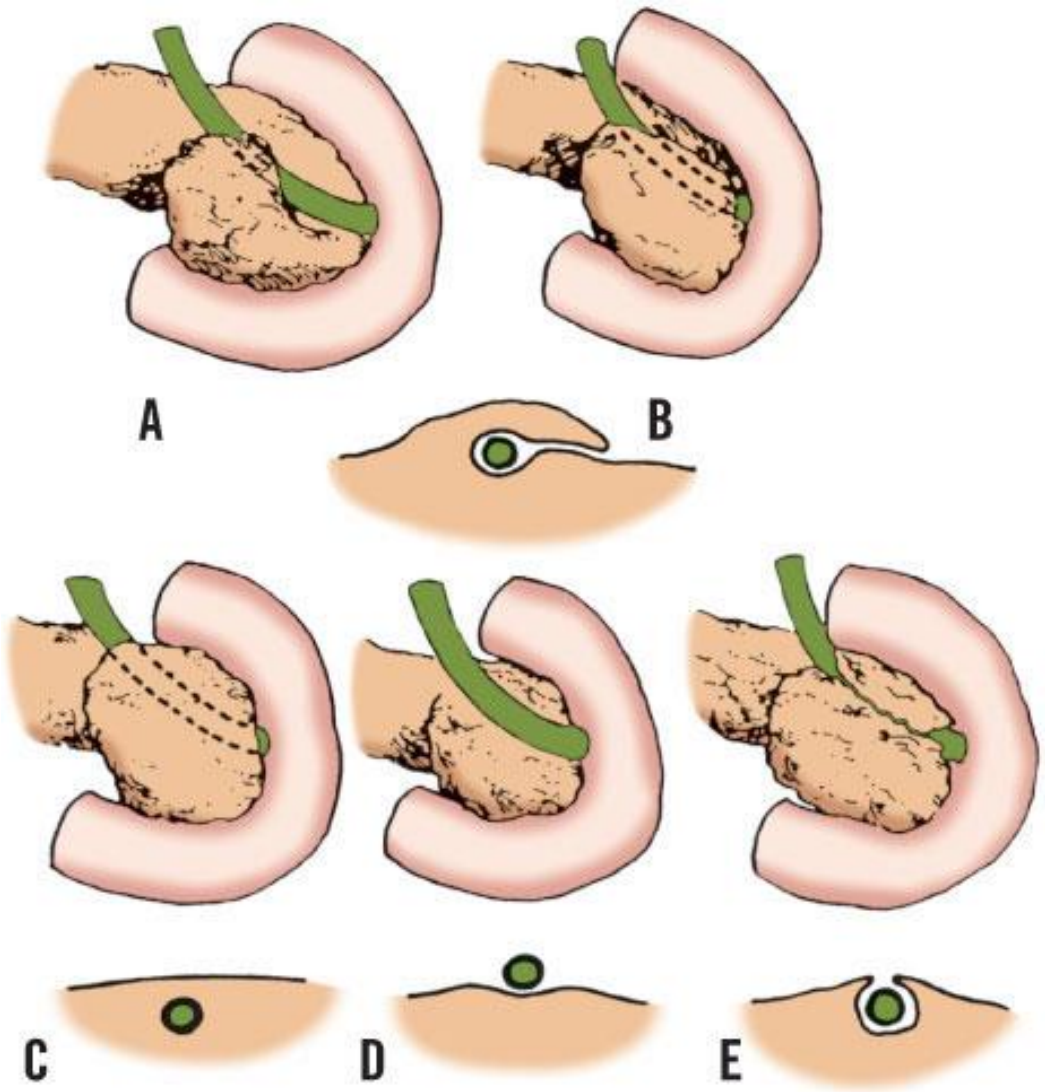
PANCREATIC DUCTS

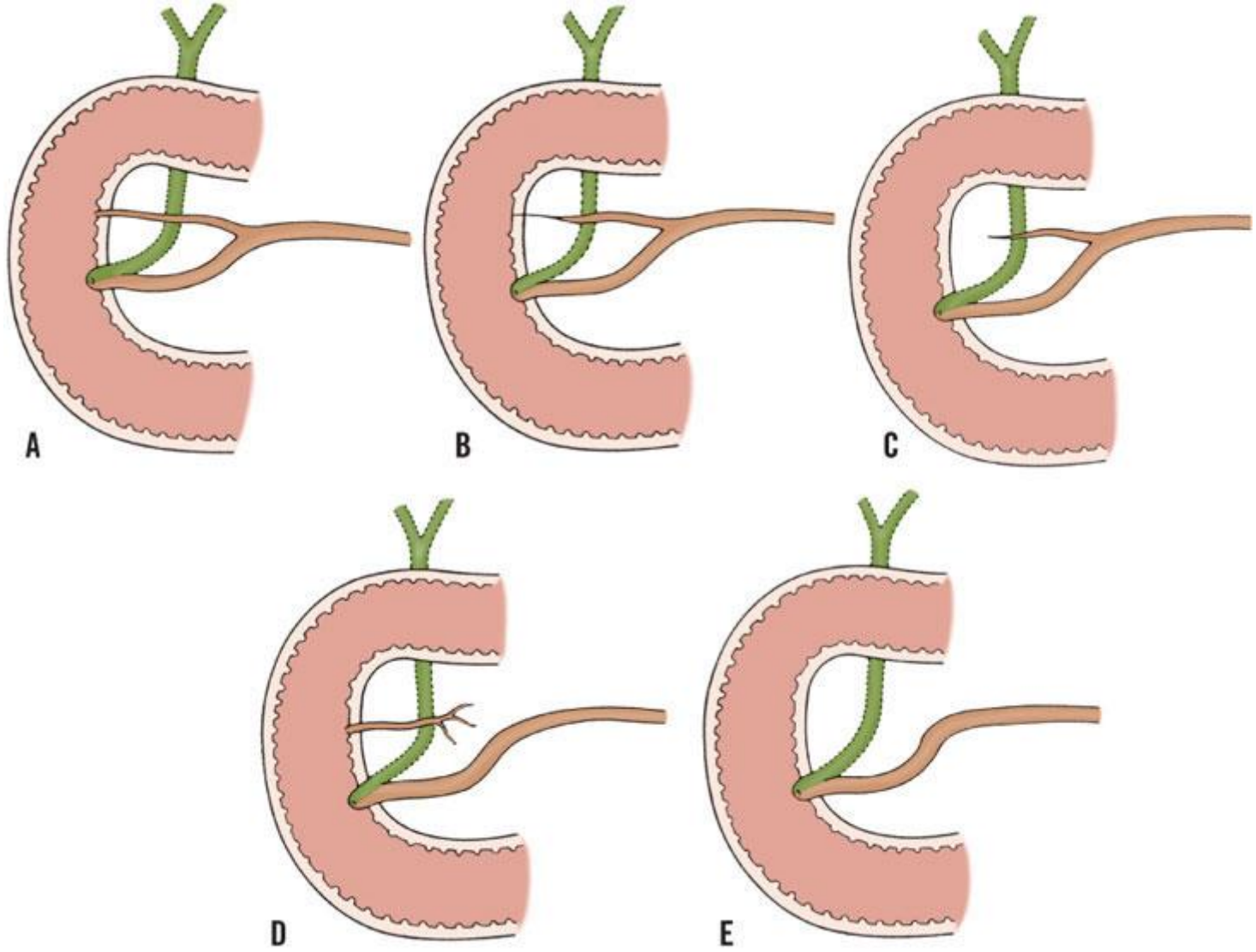
- The main duct of the pancreas begins in the tail and runs the length of the gland, receiving numerous tributaries on the way. It opens into the second part of the duodenum at about its middle with the bile duct on the major duodenal papilla.

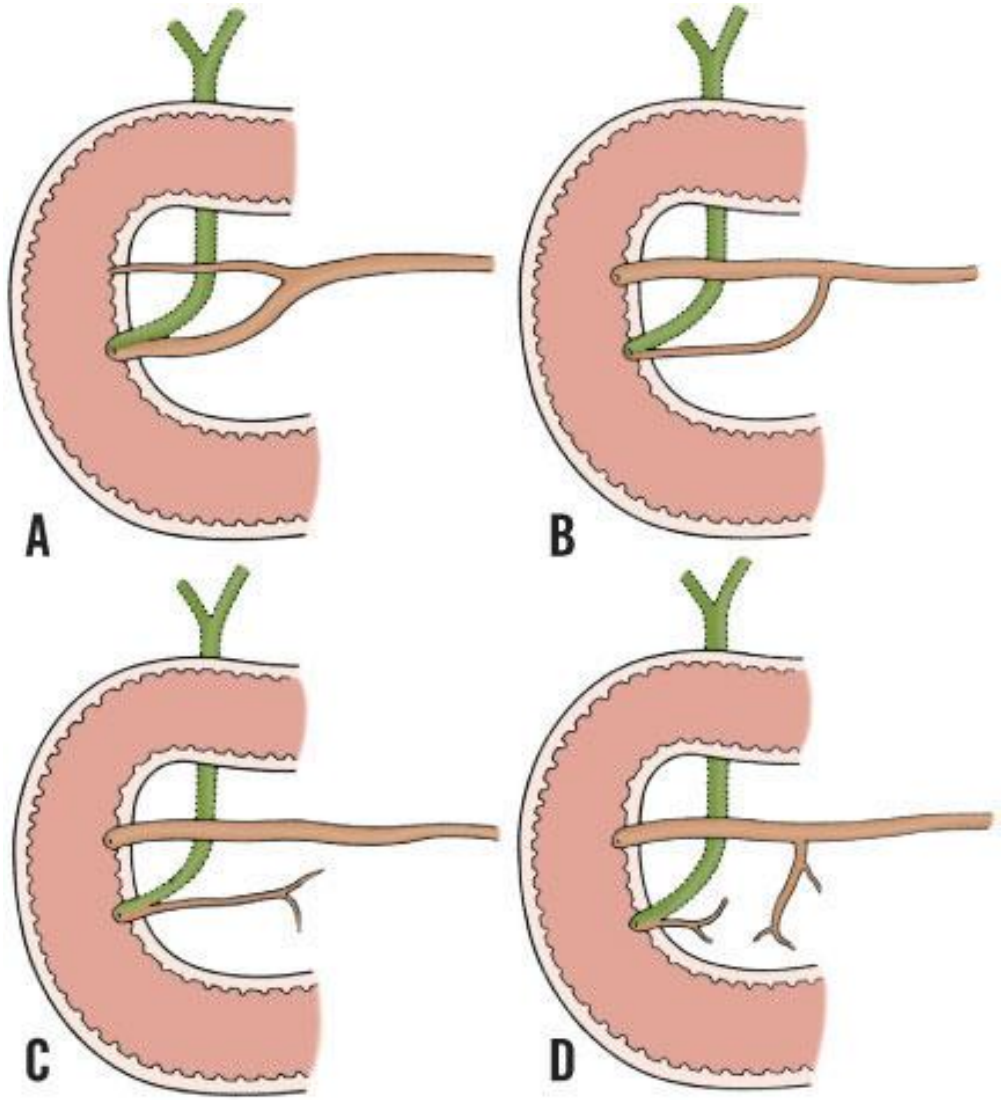
Sometimes the main duct drains sererately.

- The accessory duct of the pancreas, when present, drains the upper part of the head and then opens into the duodenum a short distance above the main duct on the minor duodenal papilla.

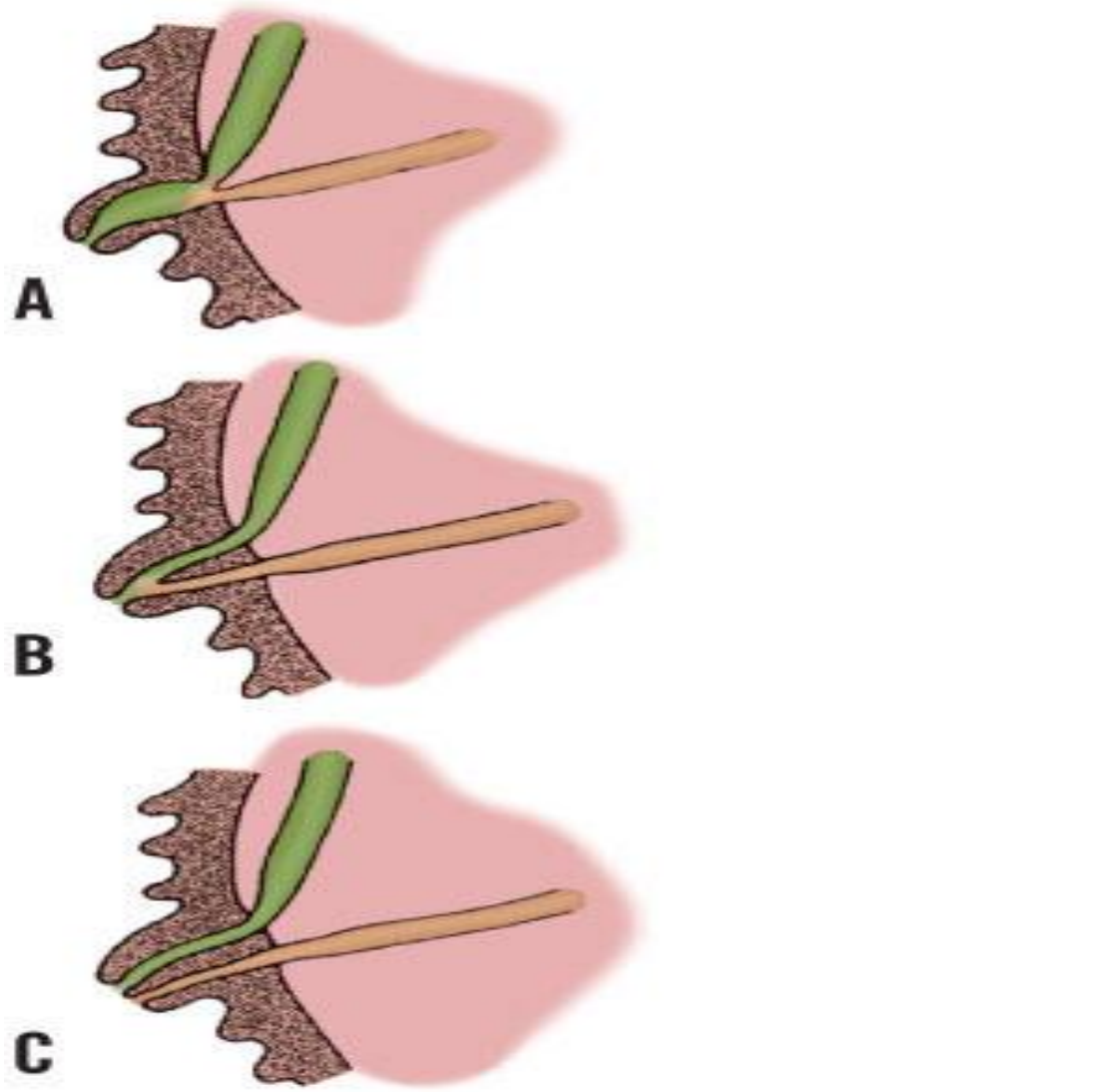
The accessory duct frequently communicates with the main duct.



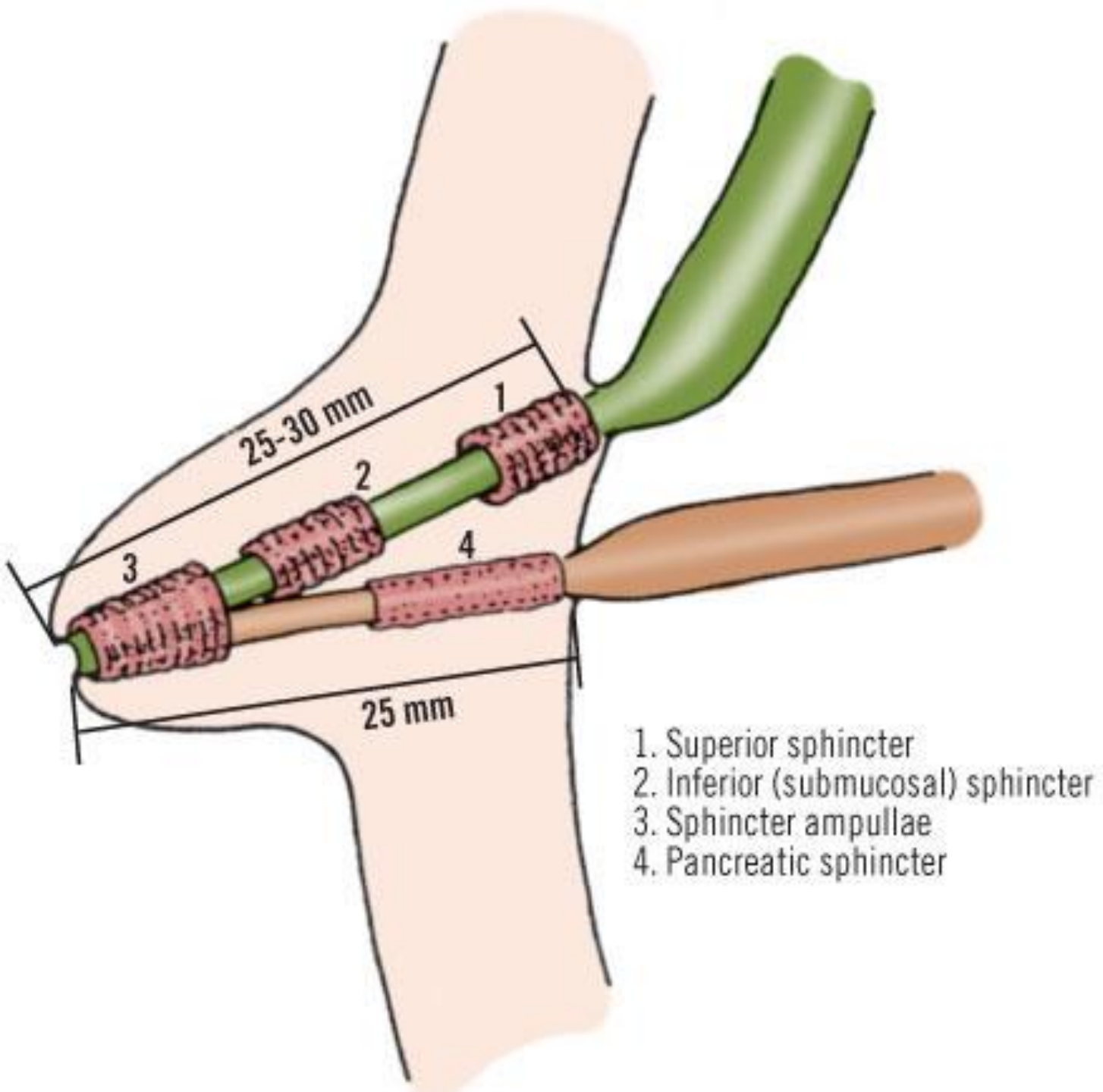


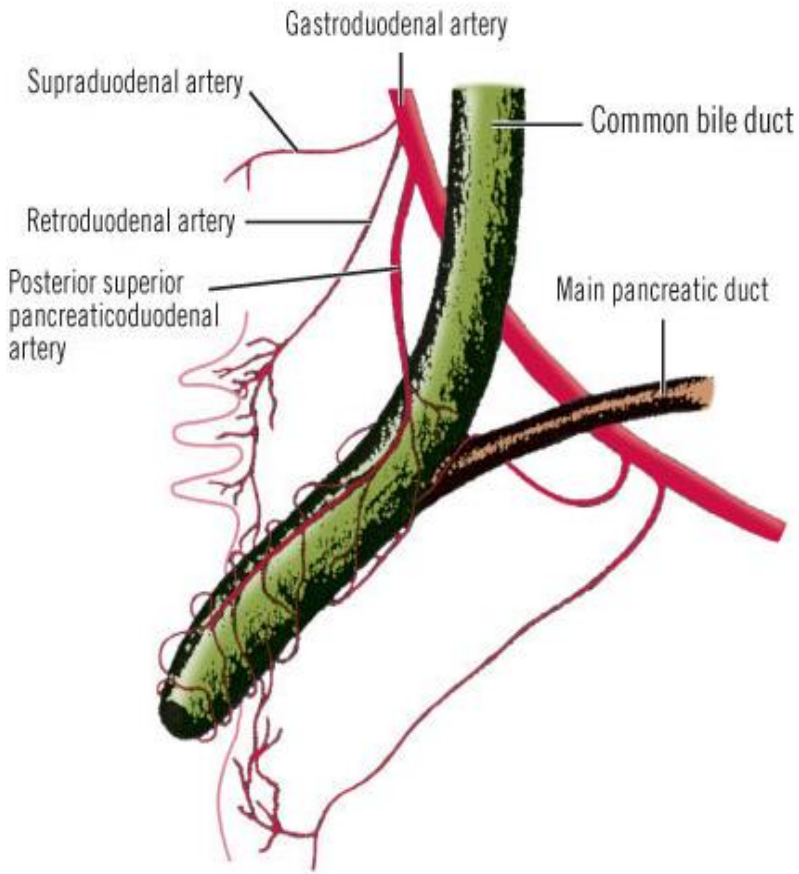


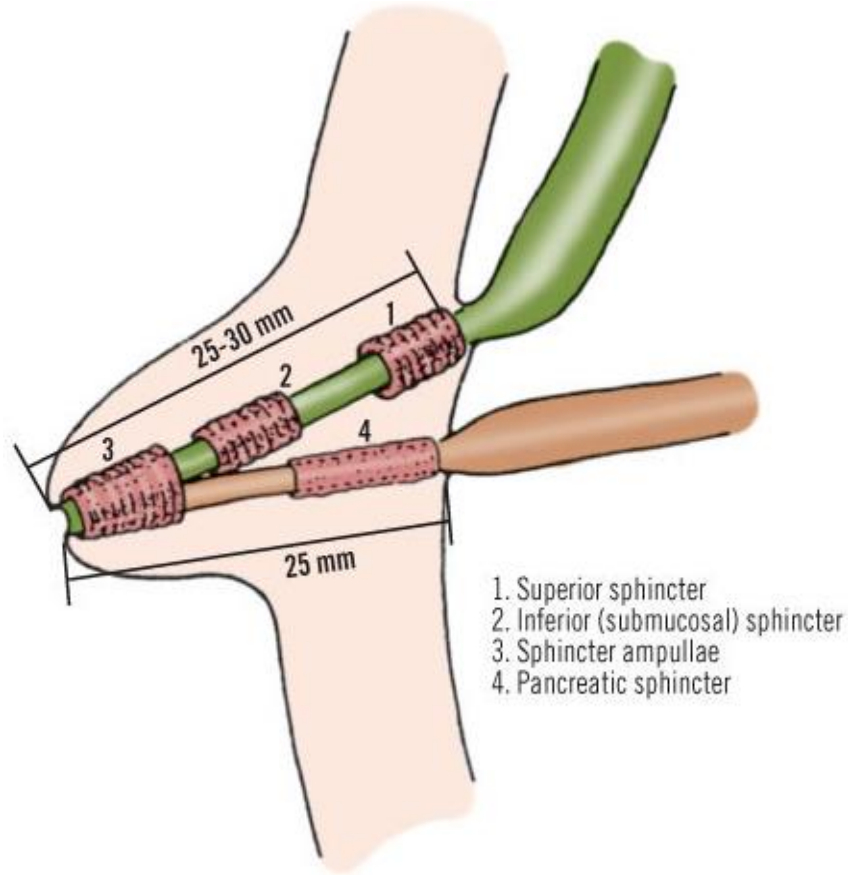
PAPILLA AND AMPULLA OF VATER



SPHINCTER OF ODDI




Gastroduodenal artery
Supraduodenal artery
Common bile duct
Retroduodenal artery
Posterior superior pancreaticoduodenal artery
Main pancreatic duct


25-30 mm
1
2
3
4
25 mm
1. Superior sphincter
2. Inferior (submucosal) sphincter
3. Sphincter ampullae
4. Pancreatic sphincter

BLOOD SUPPLY,NERVE SUPPLY

- Arteries.

The splenic and the superior and inferior pancreaticoduodenal arteries supply the pancreas.

- Veins.

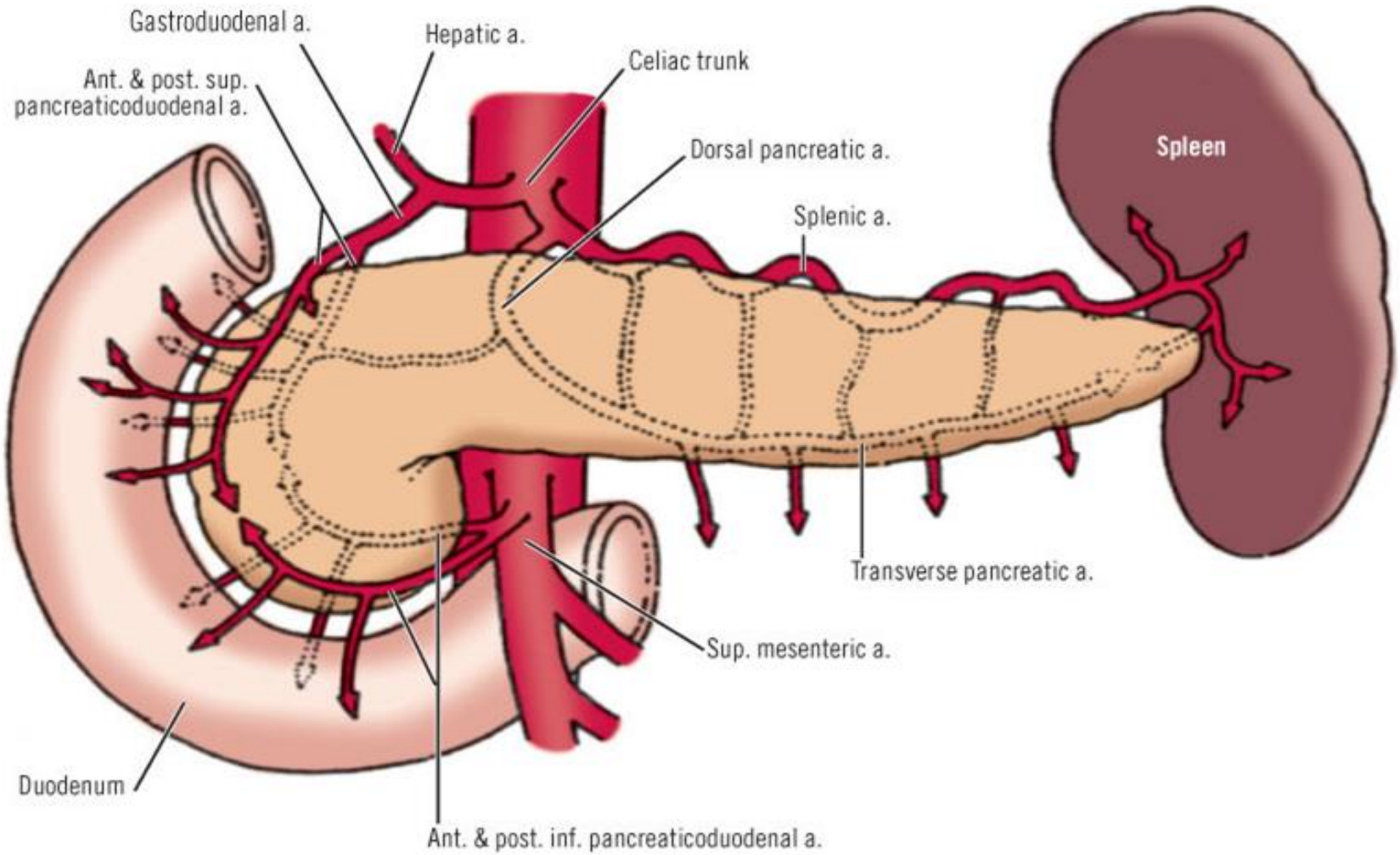
The corresponding veins drain into the portal system.

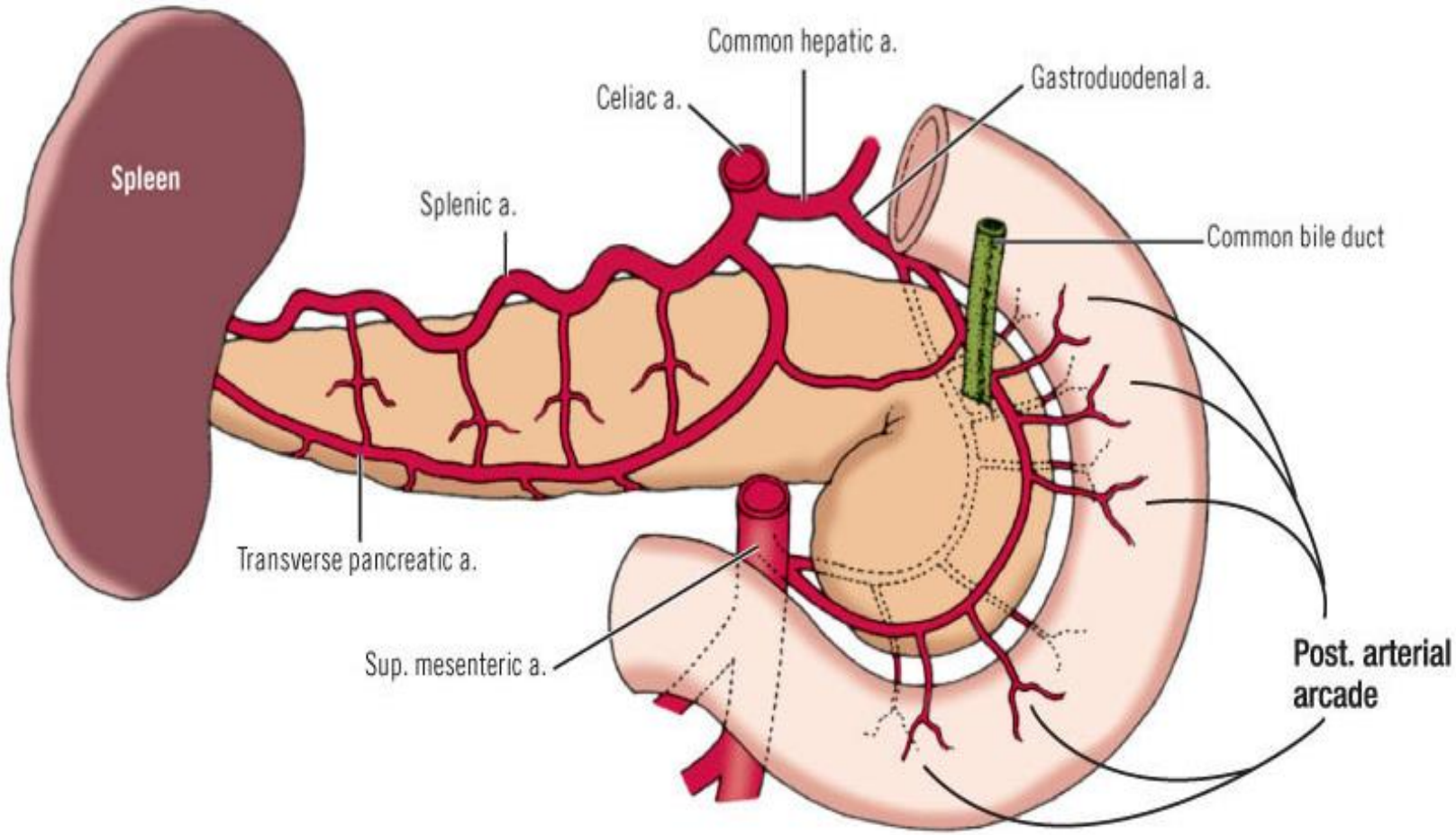
- Lymph Drainage.

Lymph nodes are situated along the arteries that supply the gland. The efferent vessels ultimately drain into the celiac and superior mesenteric lymph nodes.

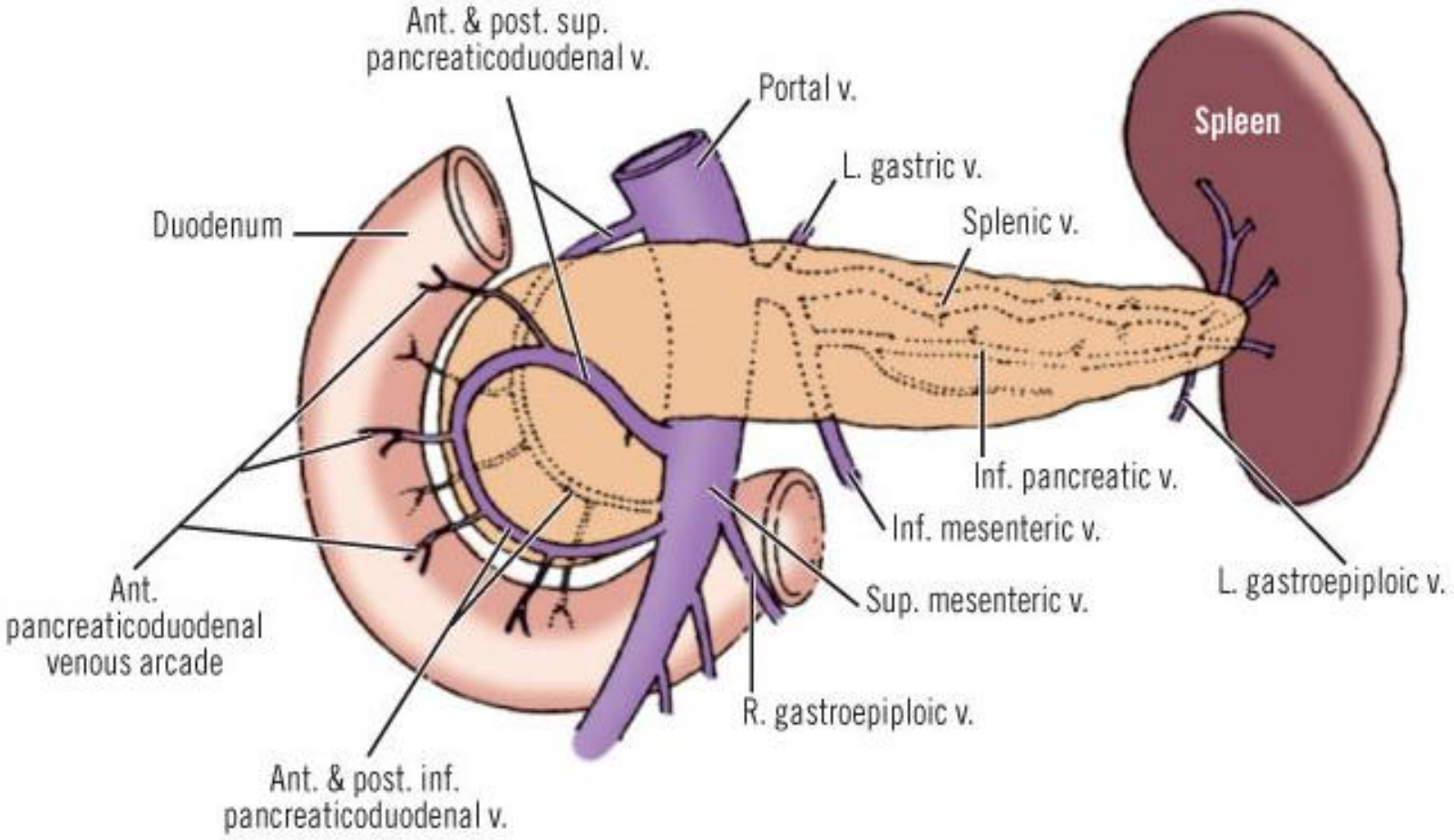
- Nerve Supply

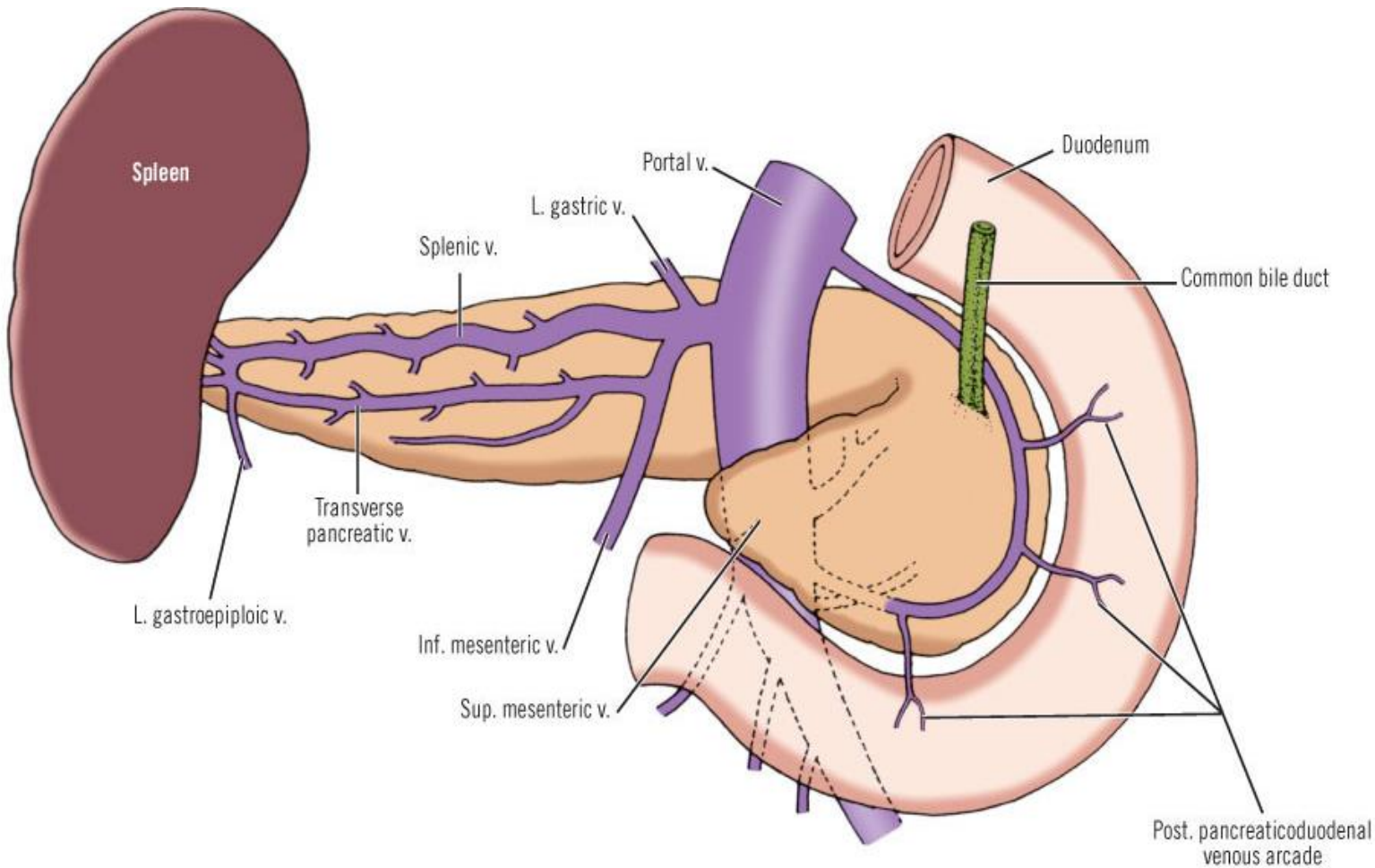
Sympathetic and parasympathetic (vagal) nerve fibers supply the area.

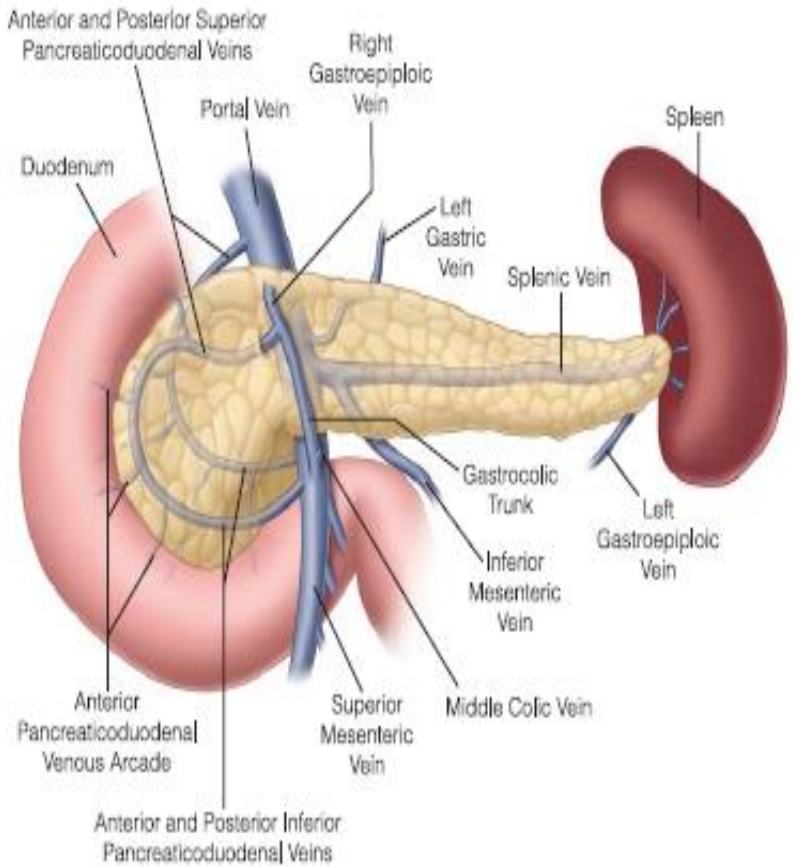

Gastroduodenal a.
Hepatic a.
Celiac trunk
Ant. & post. sup. pancreaticoduodenal a.
Dorsal pancreatic a.
Spleen
Splenic a.
Transverse pancreatic a.
Sup. mesenteric a.
Duodenum
Ant. & post. inf. pancreaticoduodenal a.

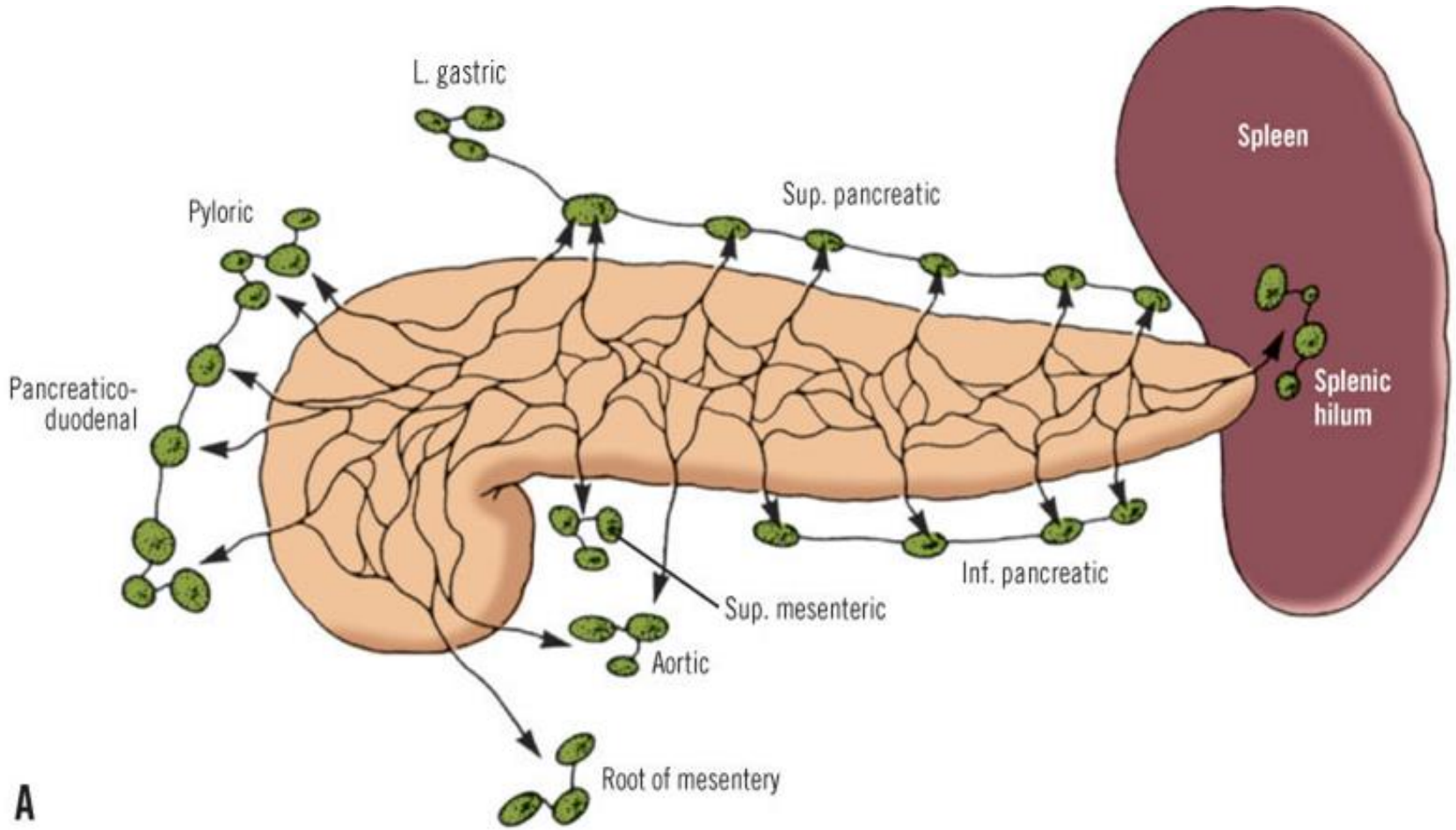

Spleen
Common hepatic a.
Celiac a.
Gastroduodenal a.
Splenic a.
Common bile duct
Transverse pancreatic a.
Sup. mesenteric a.
Post. arterial arcade

VENUS DRAINAGE

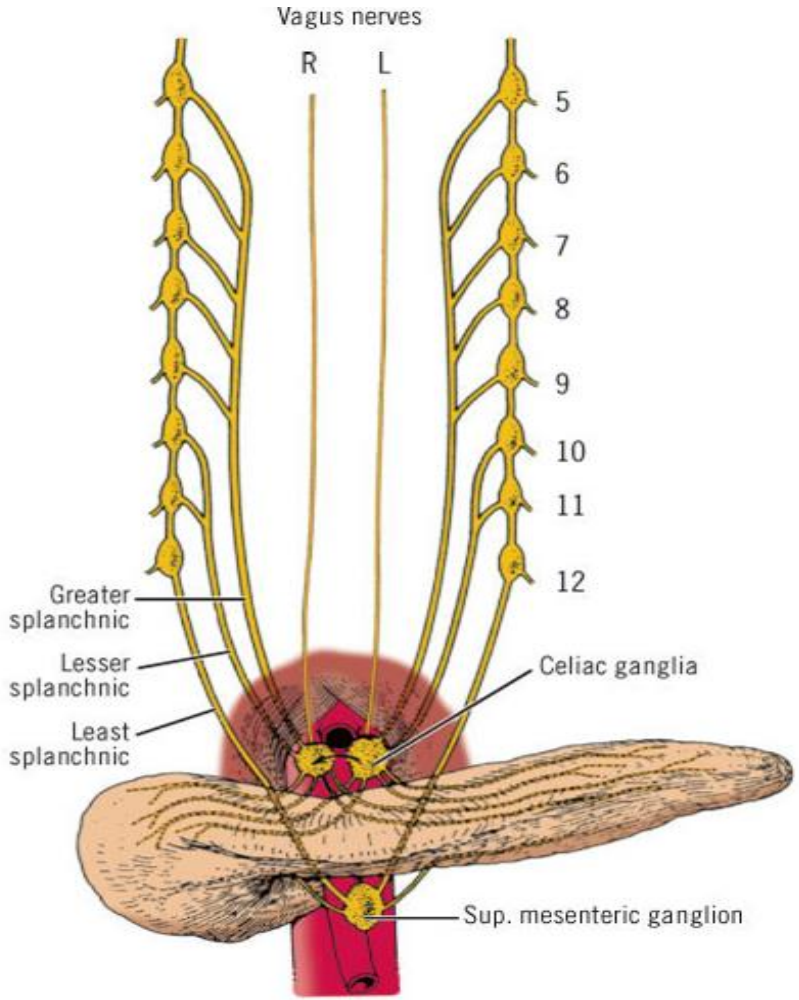


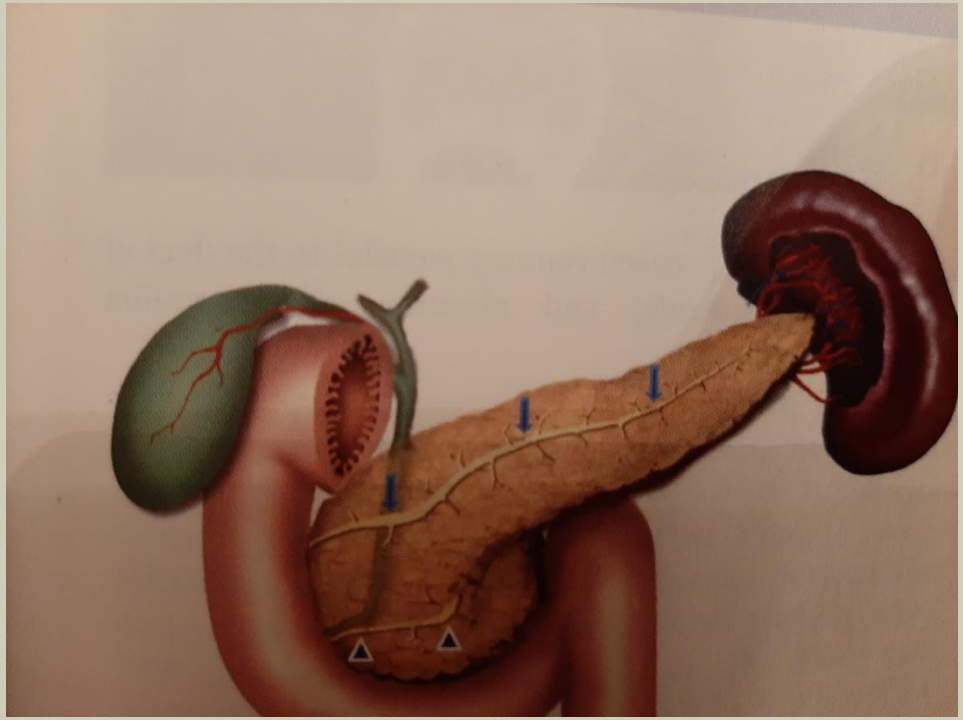

Spleen
Portal v.
L. gastric v.
Splenic v.
Duodenum
Common bile duct
Transverse pancreatic v.
L. gastroepiploic v.
Inf. mesenteric v.
Sup. mesenteric v.
Post. pancreaticoduodenal venous arcade

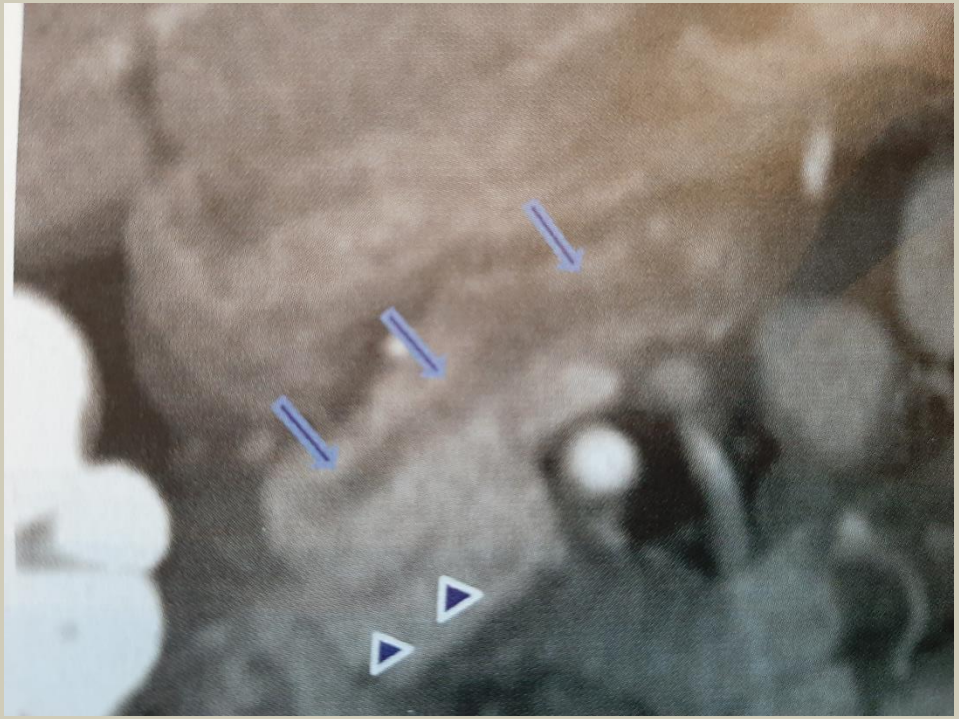

Anterior and Posterior Superior Pancreaticoduodenal Veins
Right Gastroepiploic Vein
Portal Vein
Spleen
Duodenum
Left Gastric Vein
Splenic Vein
Gastrocolic Trunk
Left Gastroepiploic Vein
Inferior Mesenteric Vein
Anterior Pancreaticoduodenal Venous Arcade
Superior Mesenteric Vein
Middle Colic Vein
Anterior and Posterior Inferior Pancreaticoduodenal Veins

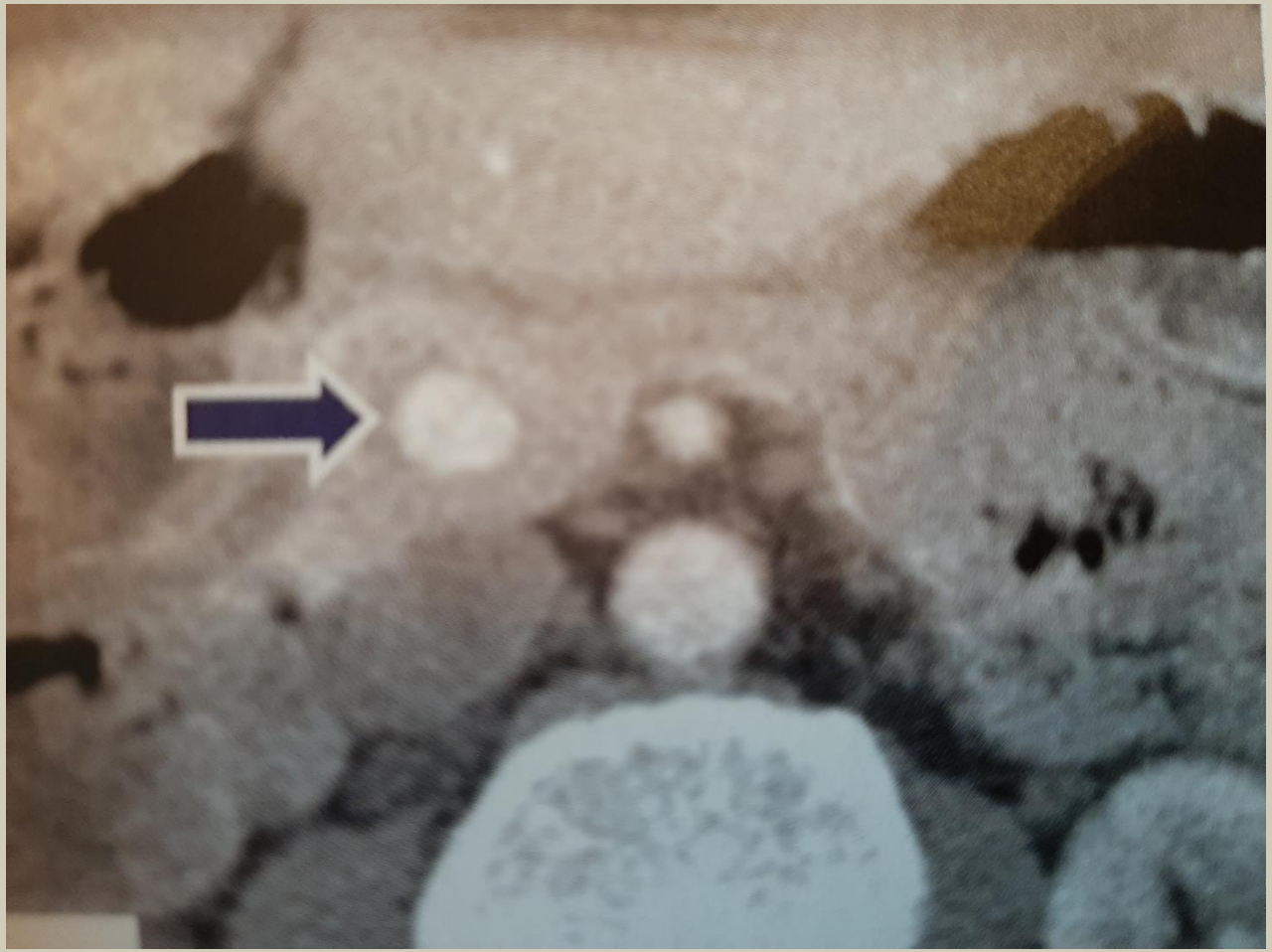

L. gastric
Pyloric
Sup. pancreatic
Spleen
Pancreatico-
duodenal
Splenic
hilum
Inf. pancreatic
Sup. mesenteric
Aortic
Root of mesentery
A

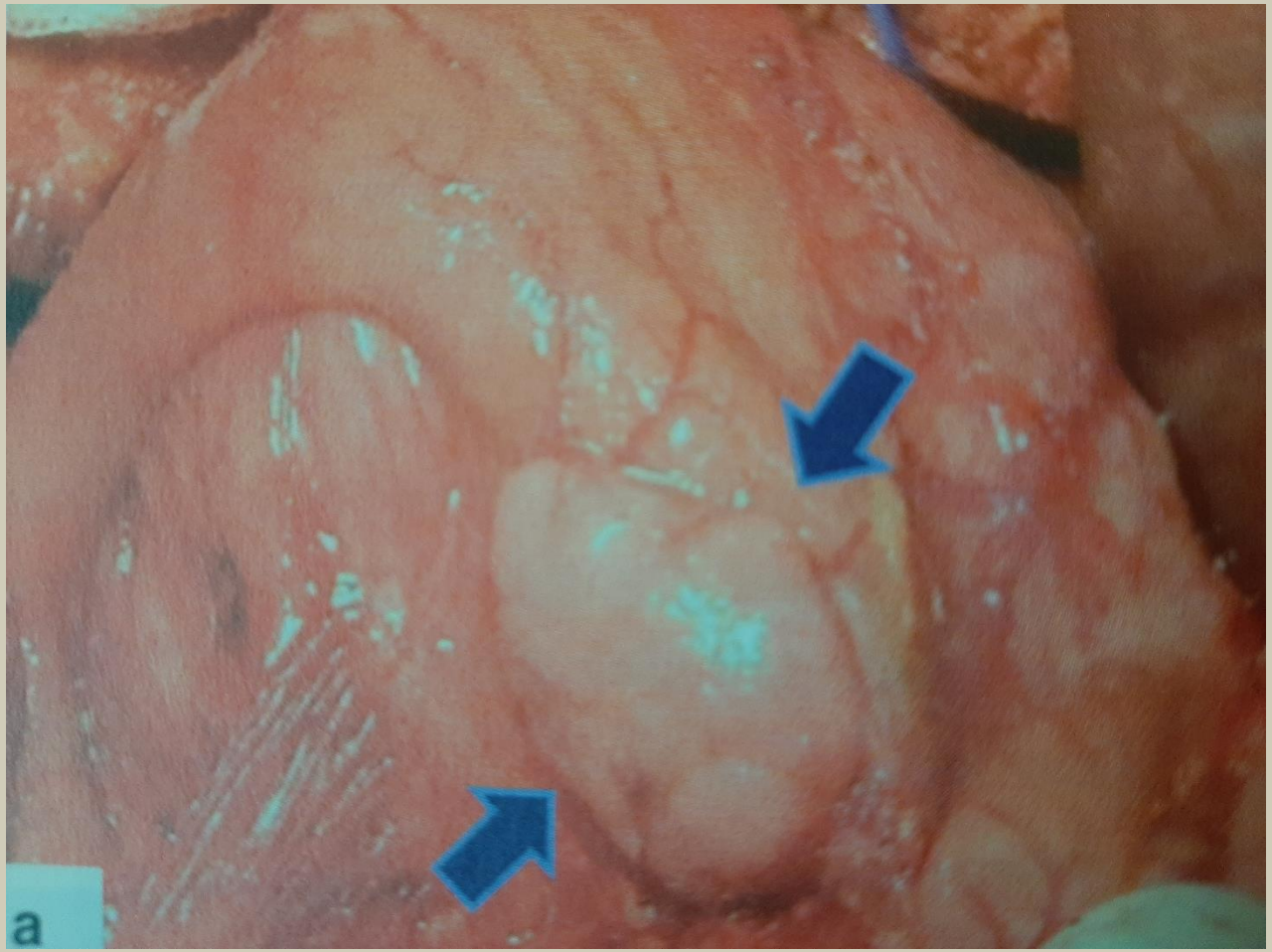
INNERVATION

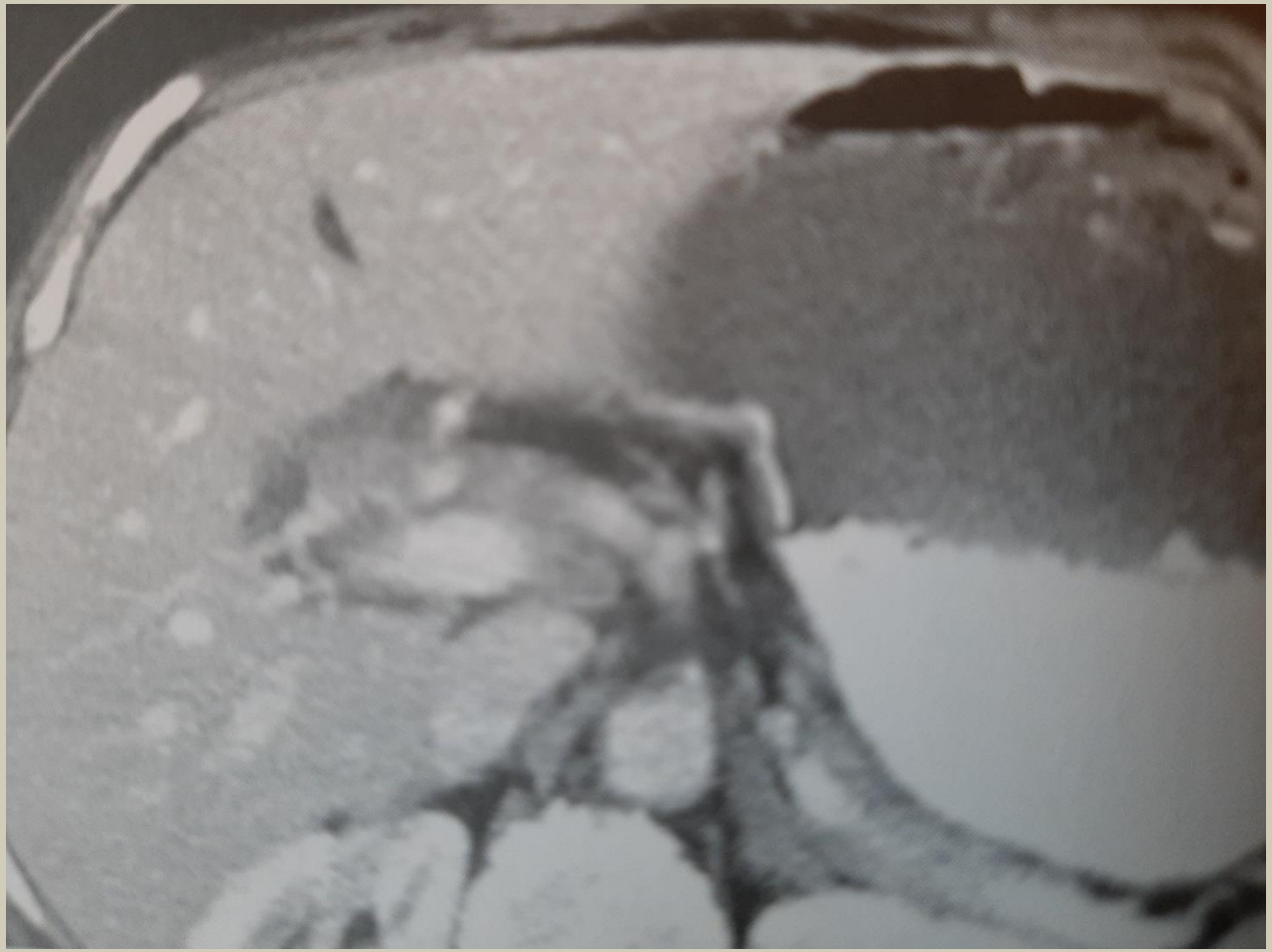









a

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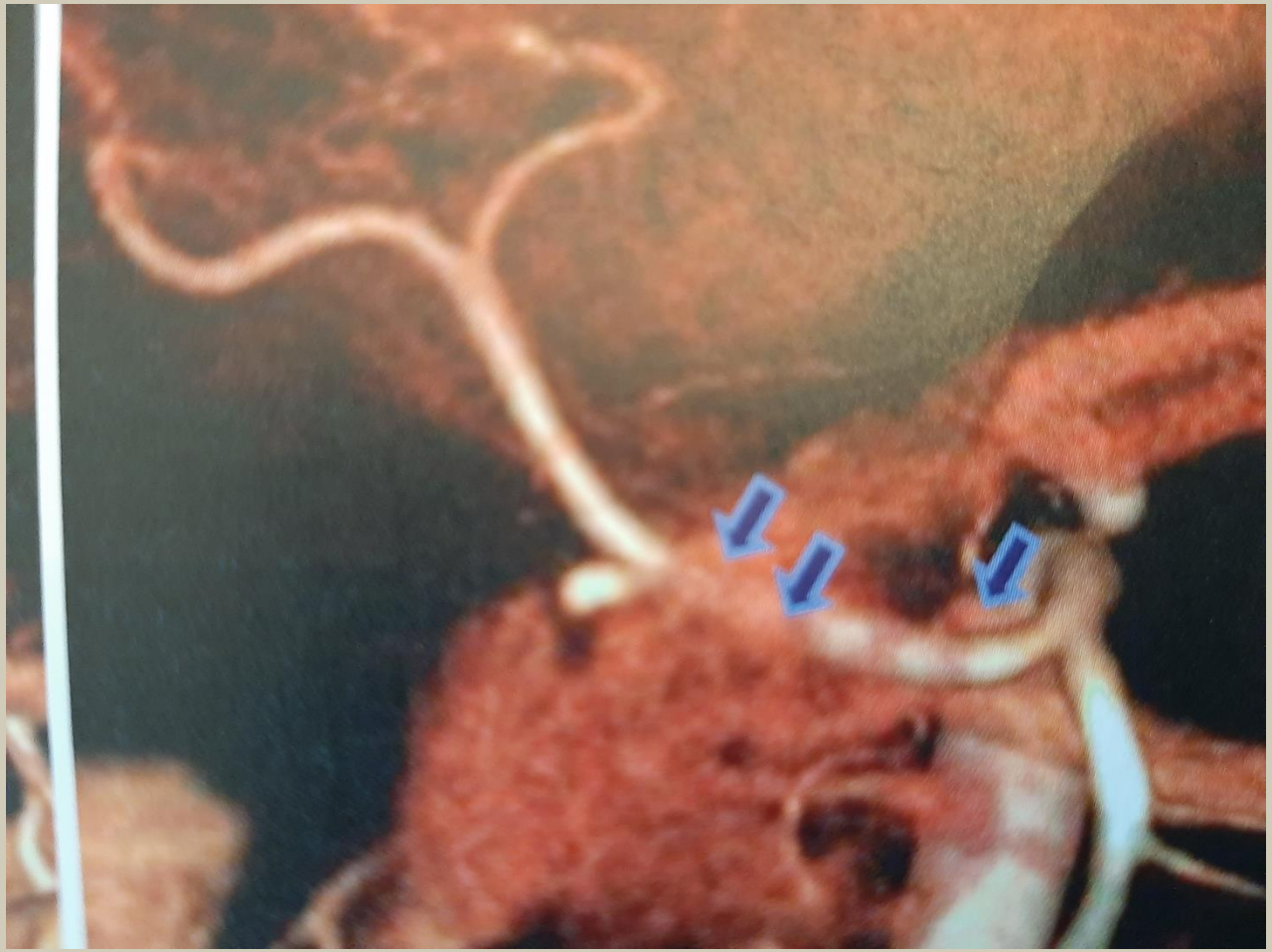
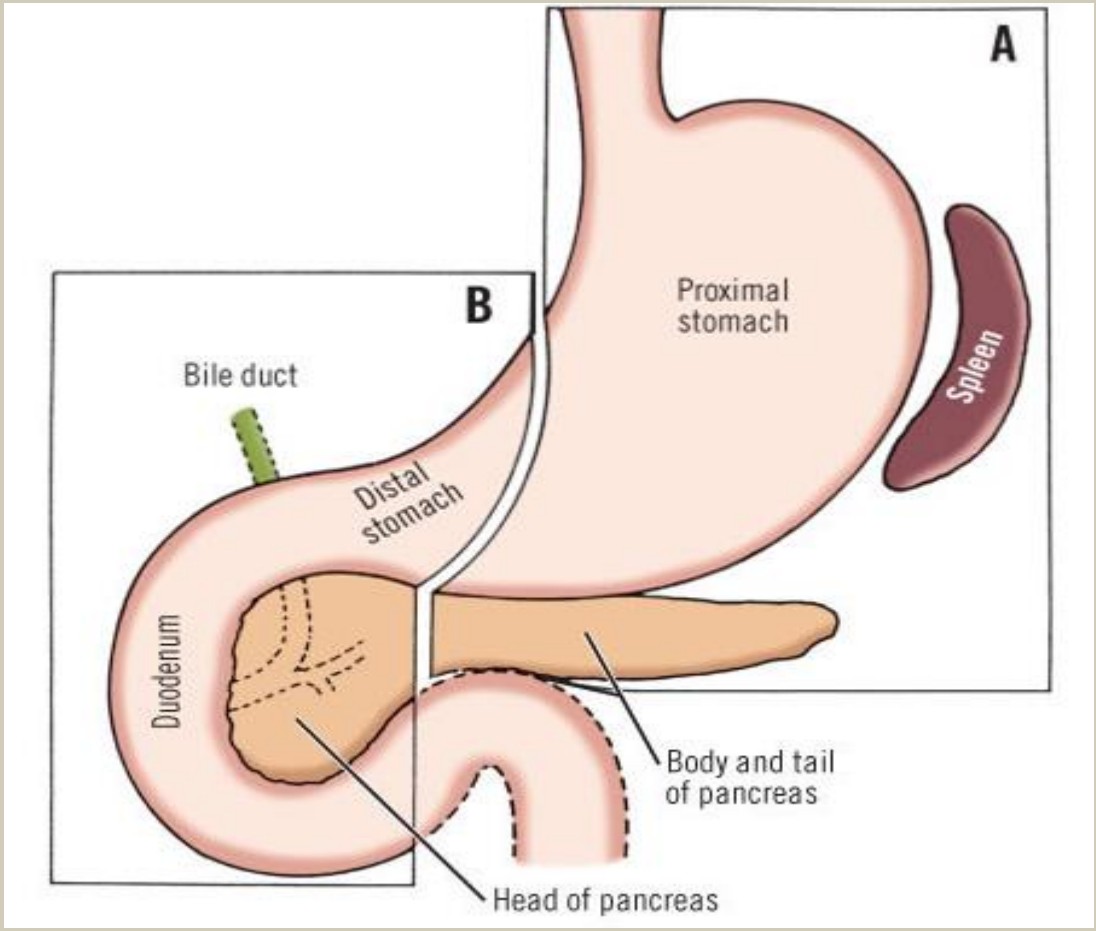
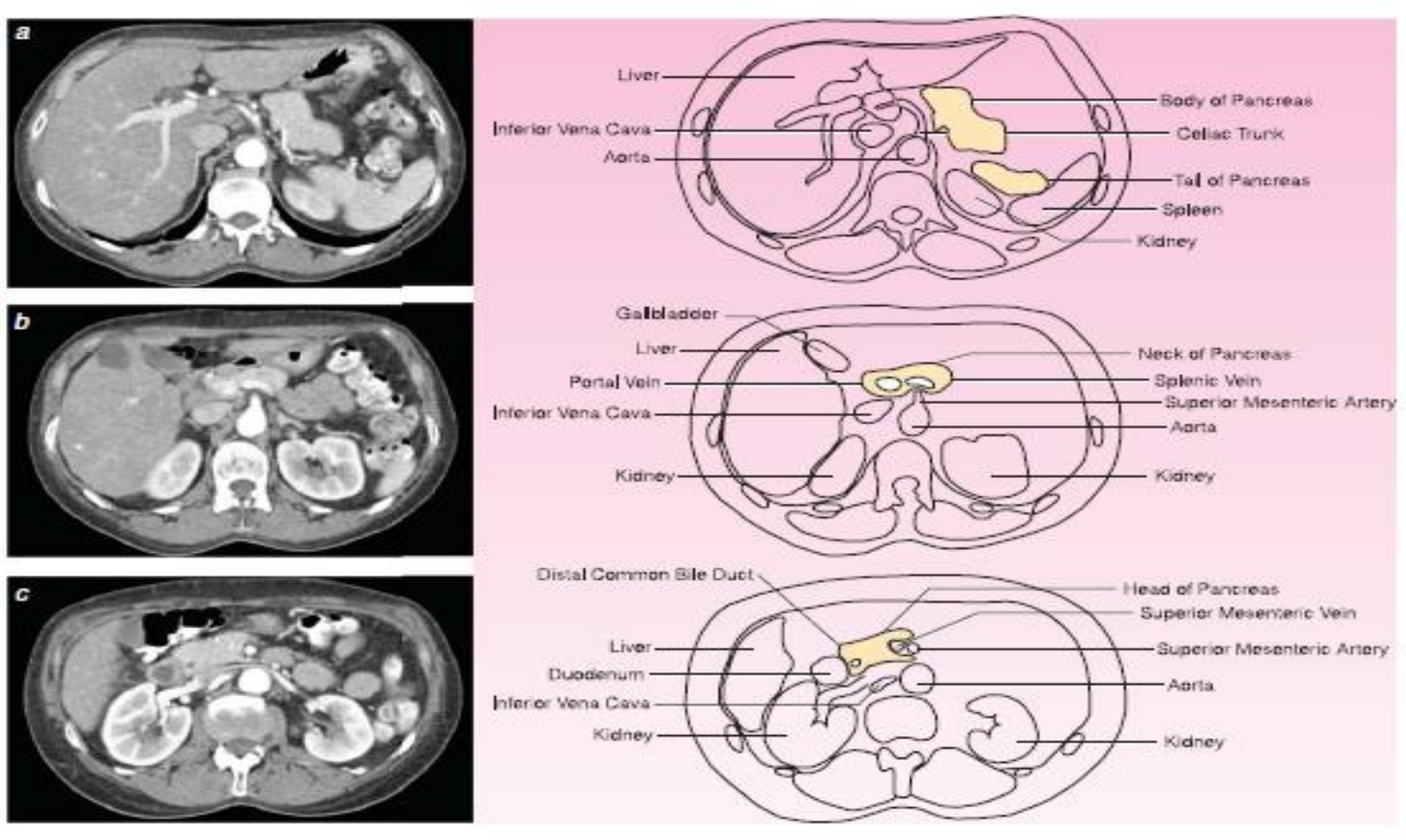


SURGICAL UNITS



CT RELATIONS



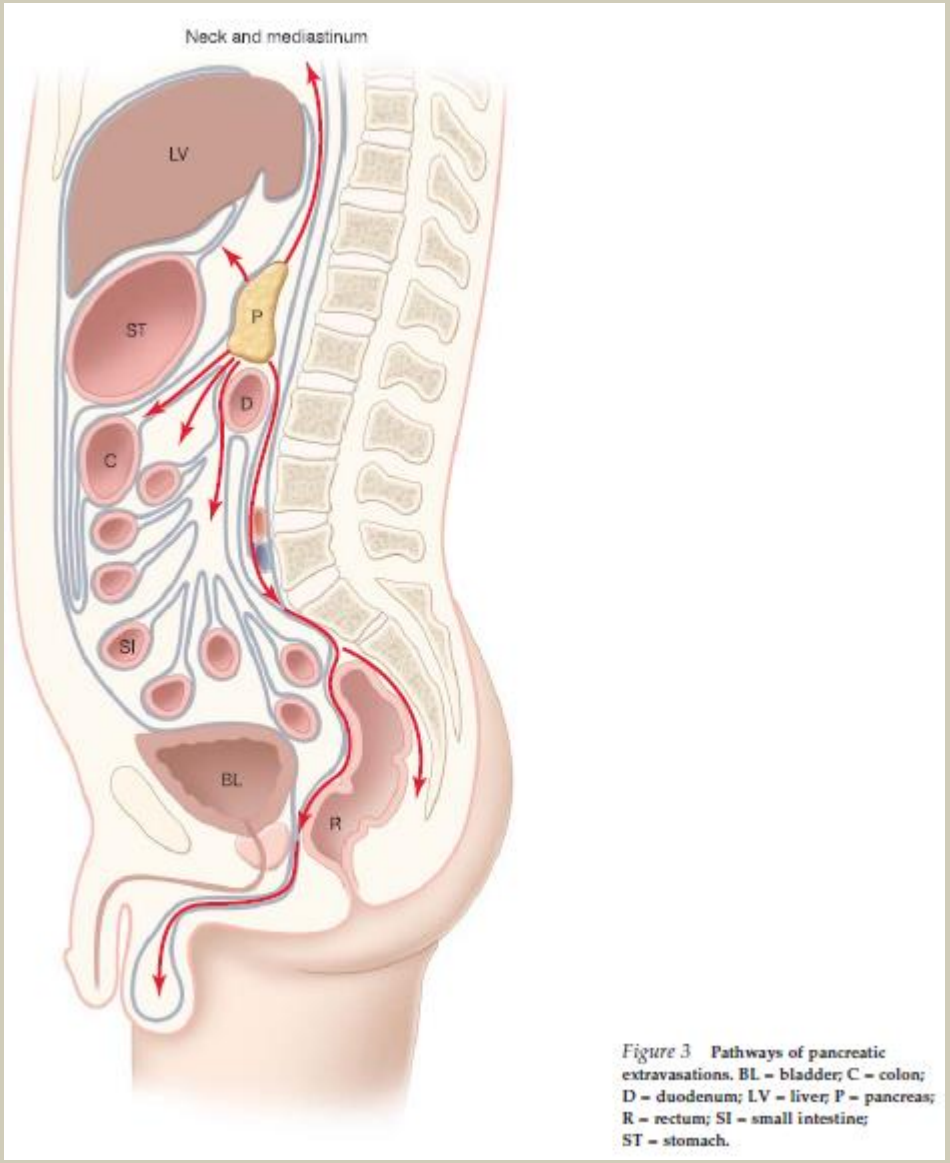
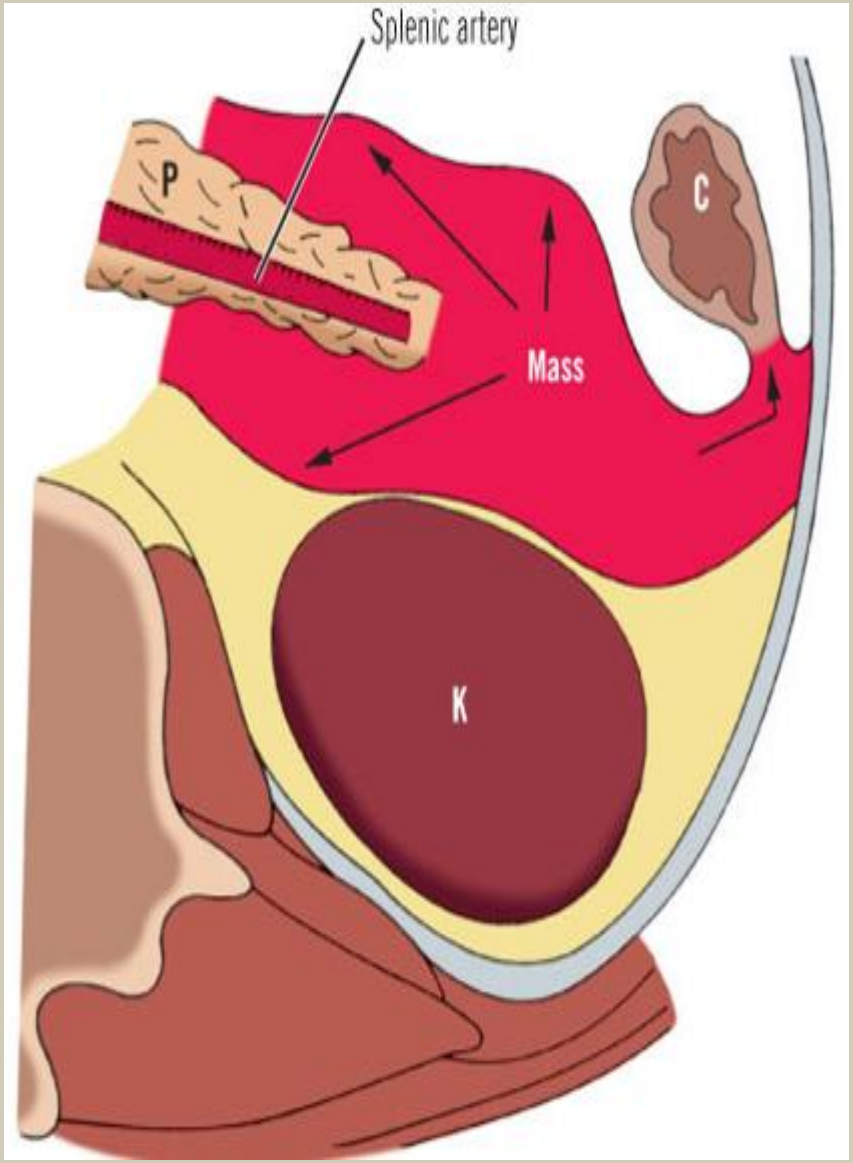
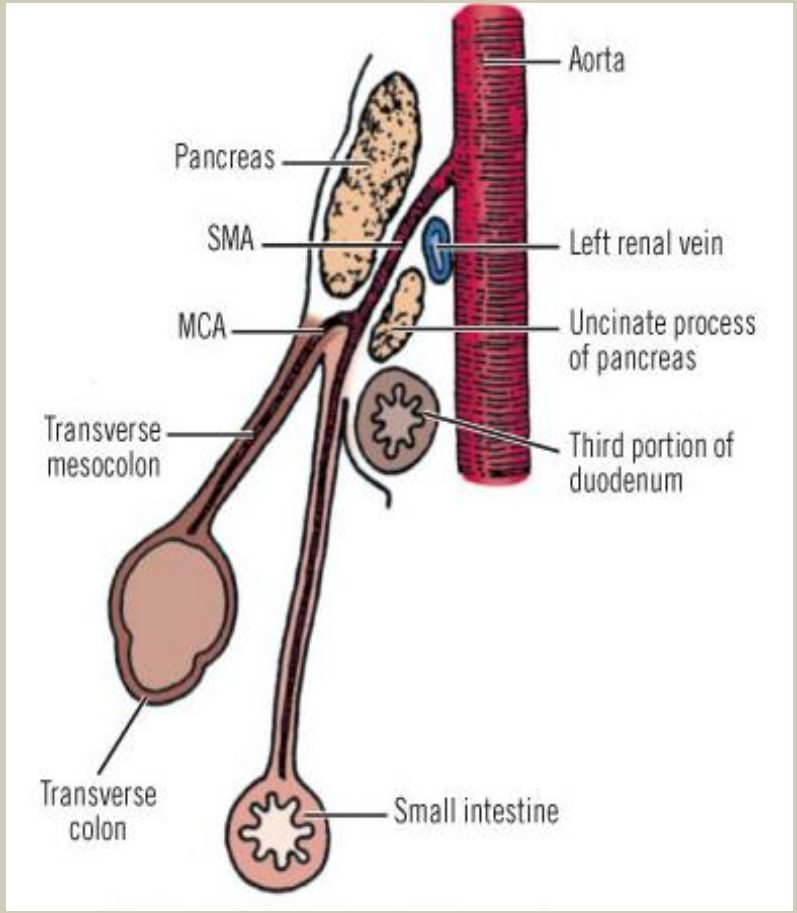
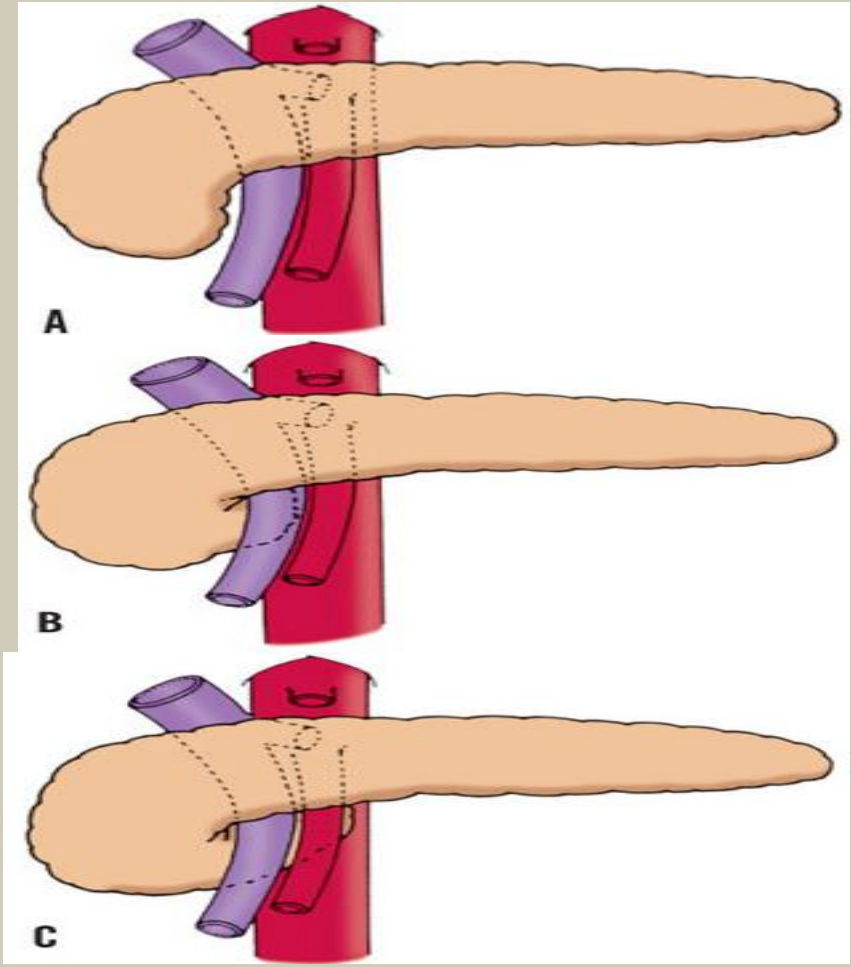


Figure 3 **Pathways of pancreatic extravasations. BL = bladder; C = colon; D = duodenum; LV = liver; P = pancreas; R = rectum; SI = small intestine; ST = stomach.**




Aorta
Pancreas
SMA
Left renal vein
MCA
Uncinate process of pancreas
Transverse mesocolon
Third portion of duodenum
Transverse colon
Small intestine


A
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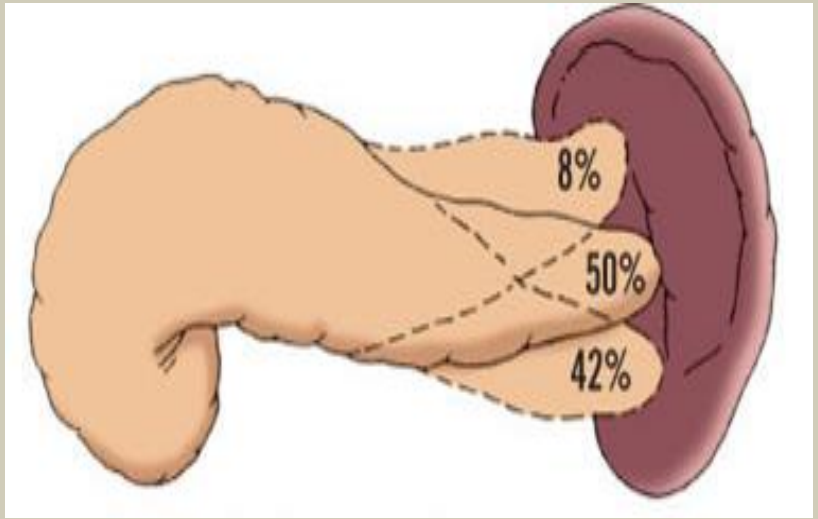
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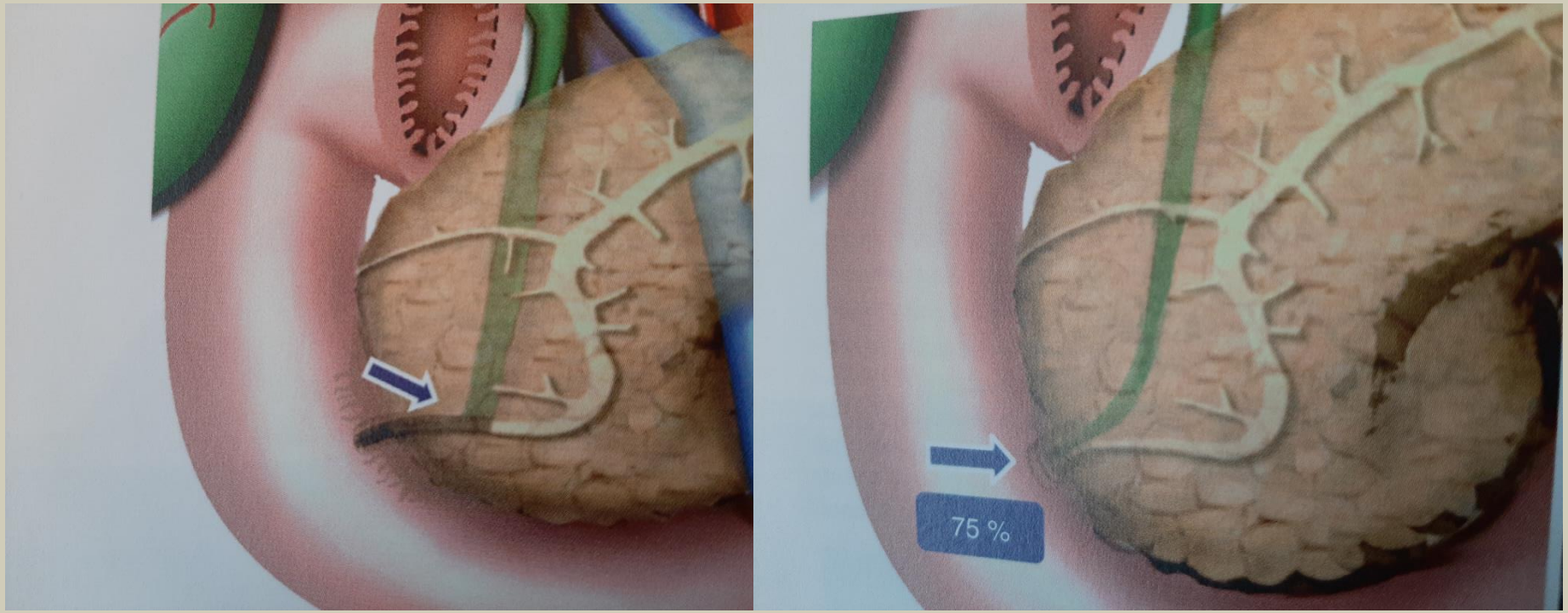
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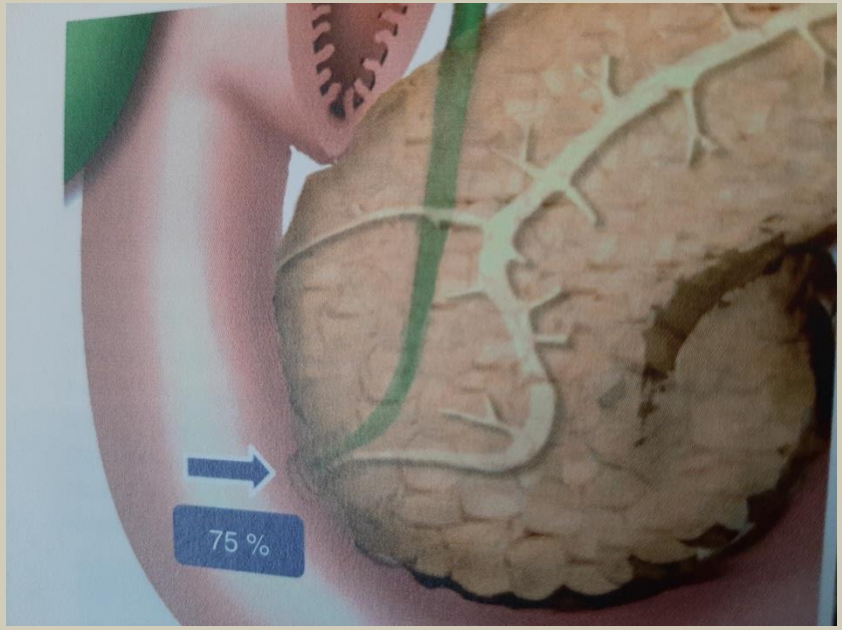
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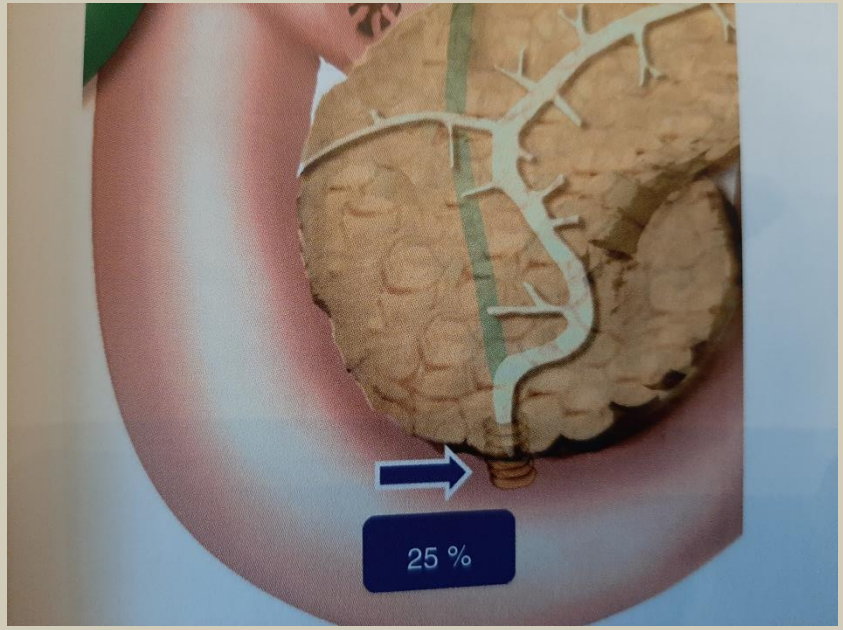
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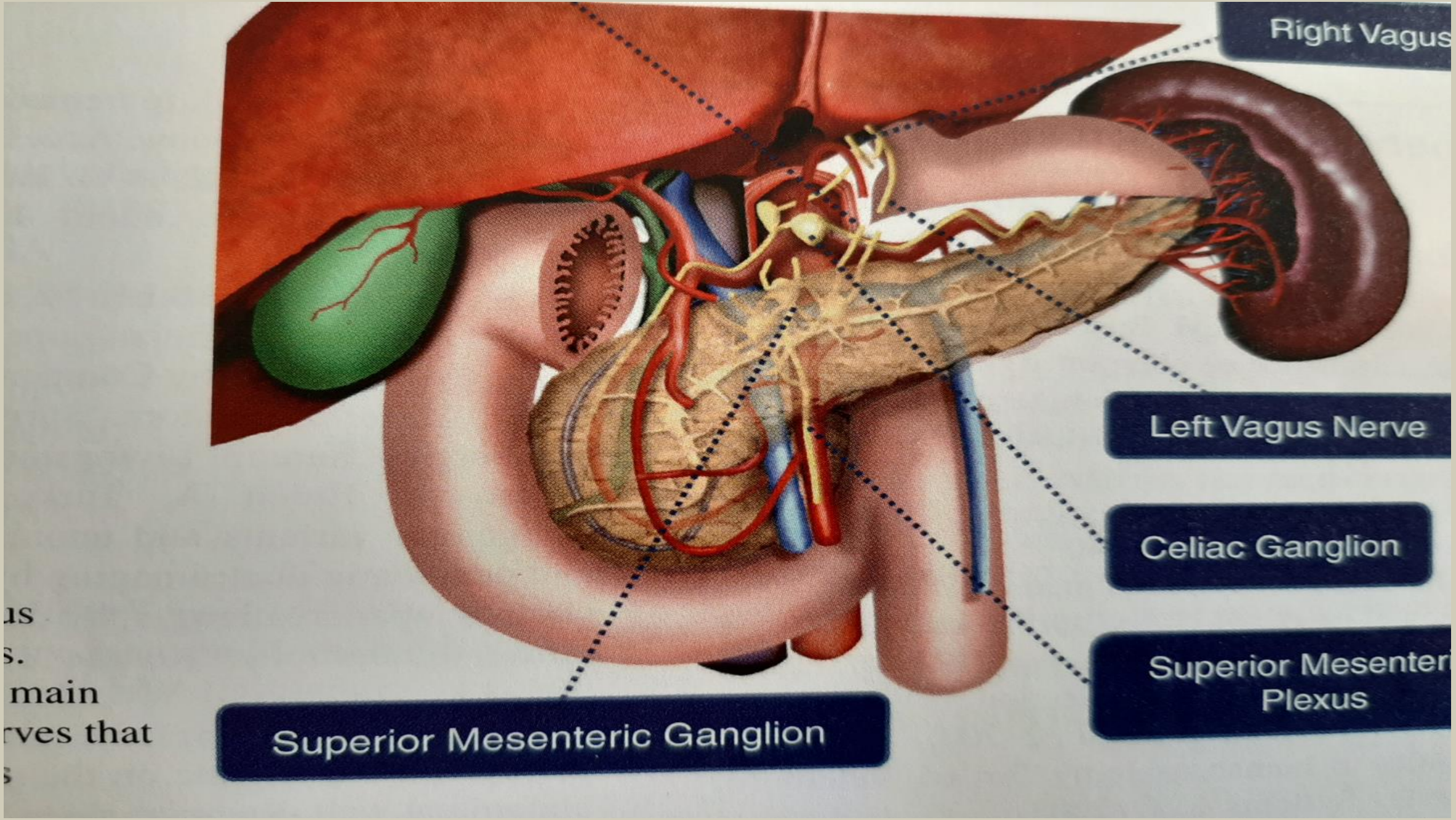

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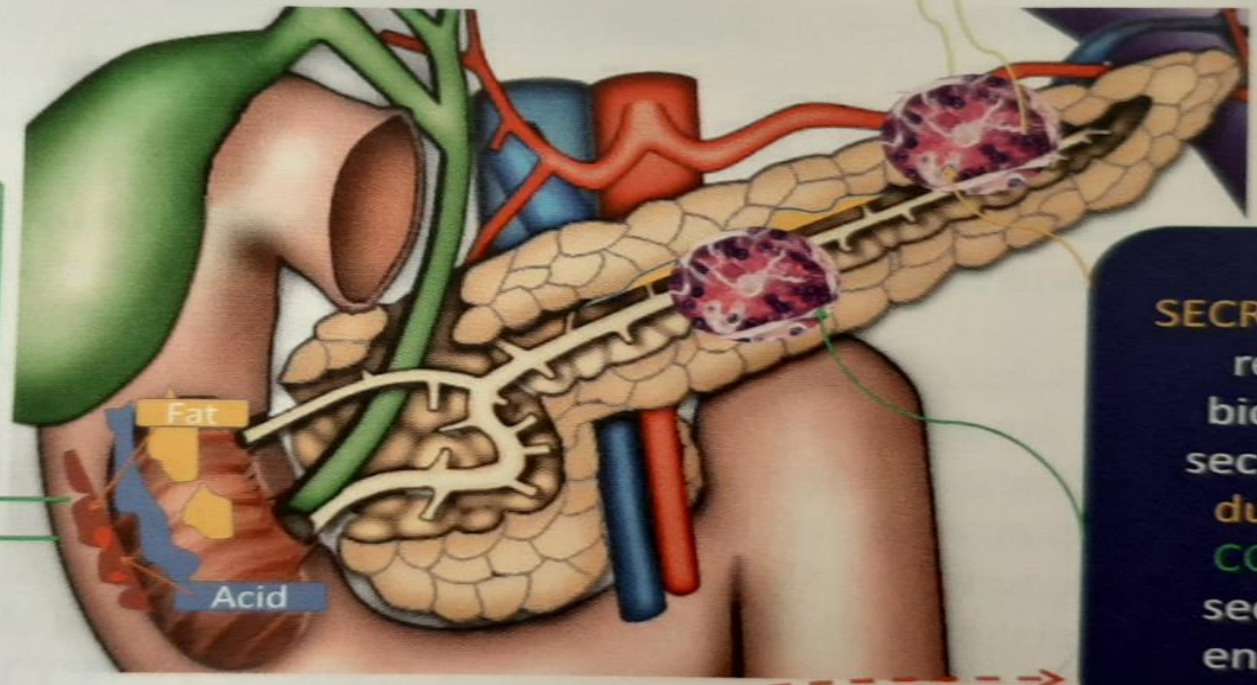
CONTROL OF PANCREATIC SECRETIONS

1
Presence of acid in the duodenum causes enteroendocrine cells of the duodenum to release secretin

Presence of fatty protein rich chyme induces release of cholecystokinin by I cells of the duodenum



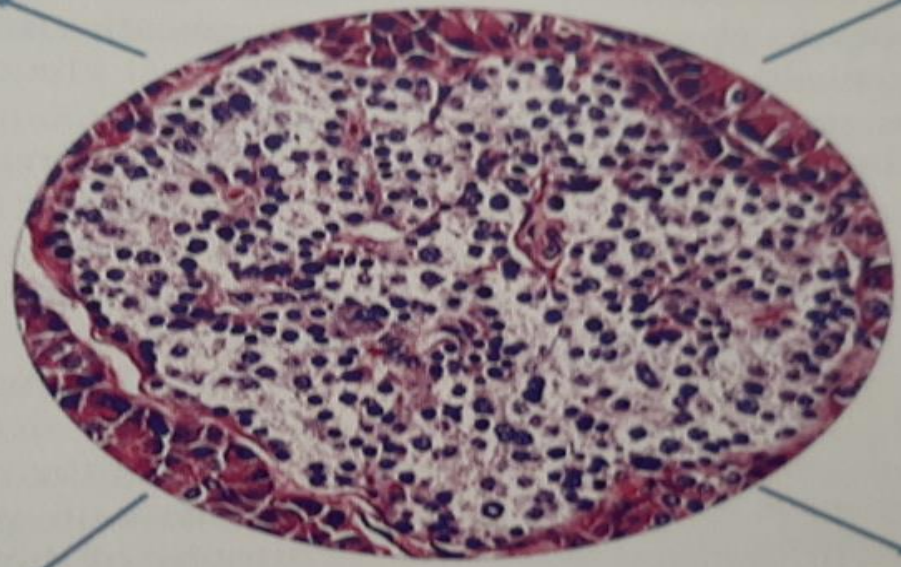
2
SECRETIN and CHOLECYSTOKININ enter the blood stream

3
SECRETIN causes release of bicarbonate secretions by ductal cells
CCK causes secretion of enzymes by acinar cells

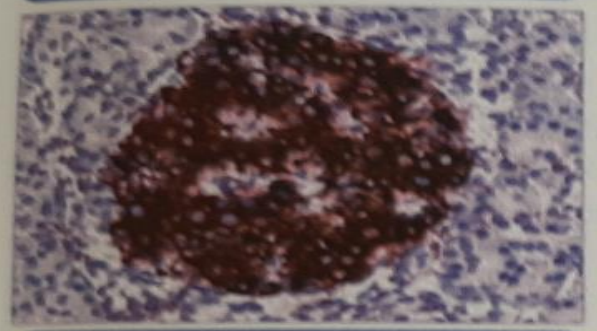
4
VAGAL STIMULATION causes release of pancreatic enzymes

Fig. 4.2 Diagram...

ENDOCRINE PANCREAS

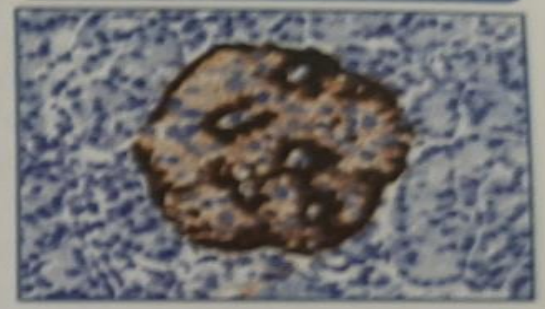


ALPHA CELLS (20%)



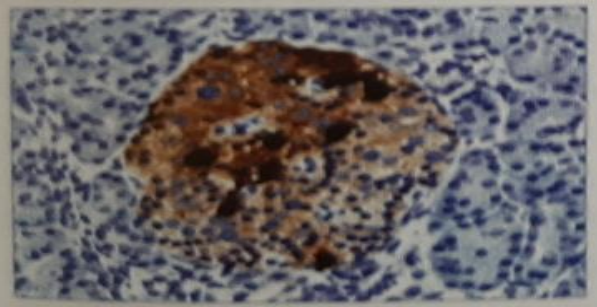
PRODUCES GLUCAGON
MAJOR CATABOLIC HORMONE OF THE BODY

BETA CELLS (68%)



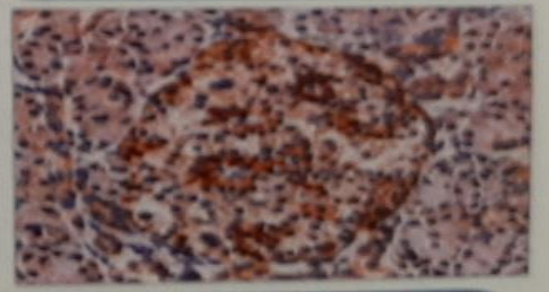
PRODUCES INSULIN
MAJOR ANABOLIC HORMONE OF THE BODY

DELTA CELLS (10%)



PRODUCES SOMATOSTATIN
INHIBITS THE SECRETION OF THE EXOCRINE PANCREAS

PP CELLS (2%)



PRODUCES PANCREATIC POLYPEPTIDE
INHIBITS PANCREATIC EXOCRINE SECRETION, GALLBLADDER CONTRACTION

ISLET OF LANGERHANS

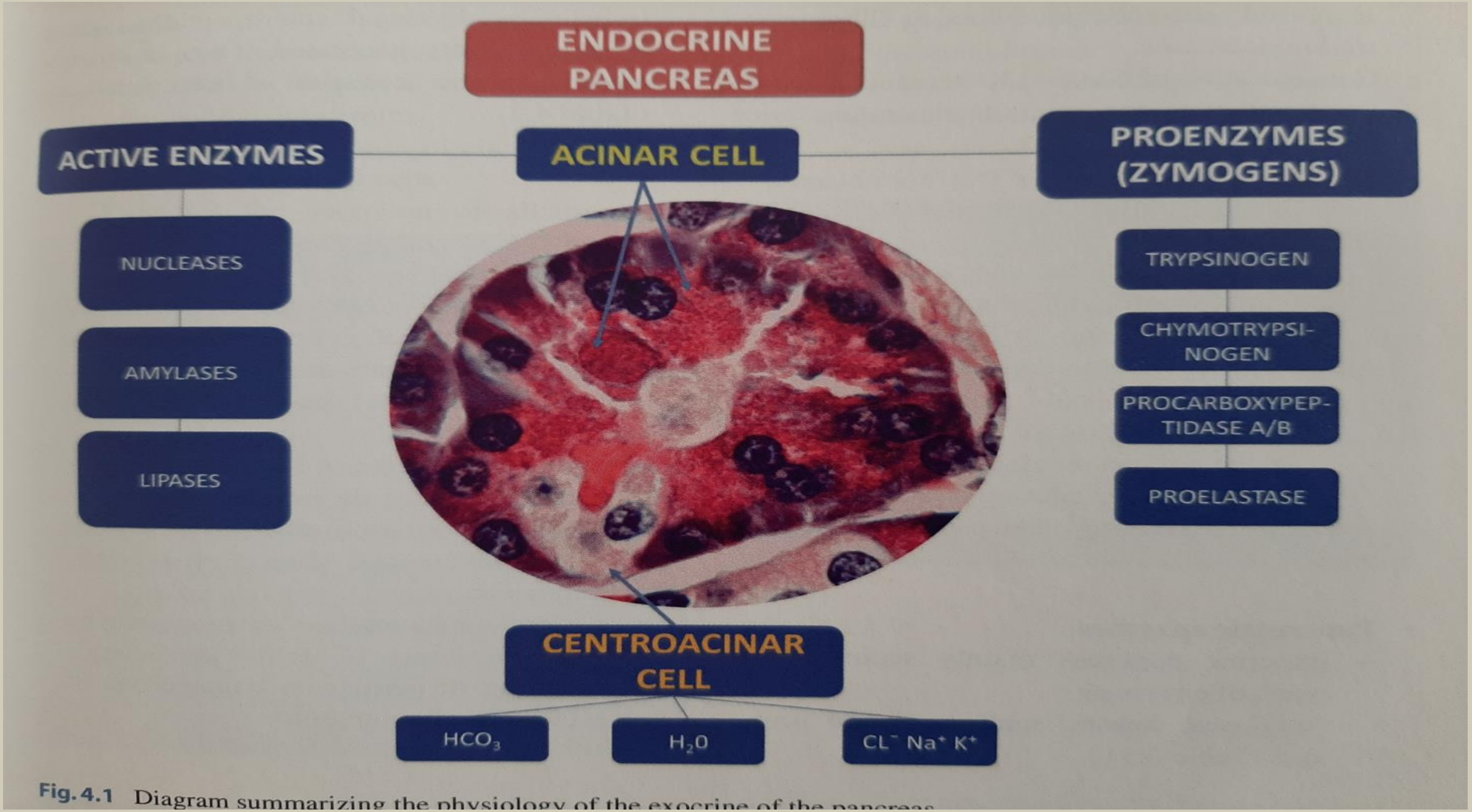
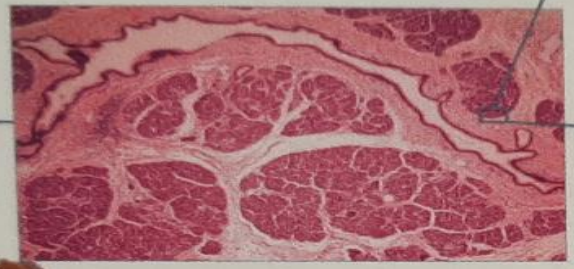
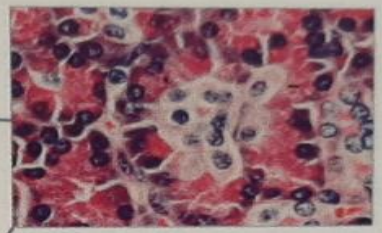


Fig. 4.1 Diagram summarizing the physiology of the exocrine of the pancreas

Interlobular ducts anastomose into branches of the main pancreatic duct, which drains the exocrine secretions into the duodenum. This low magnification of the pancreatic parenchyma illustrates the acinar arrangement that gives rise to the characteristic lobular architecture of the pancreas. H&E, 10X.

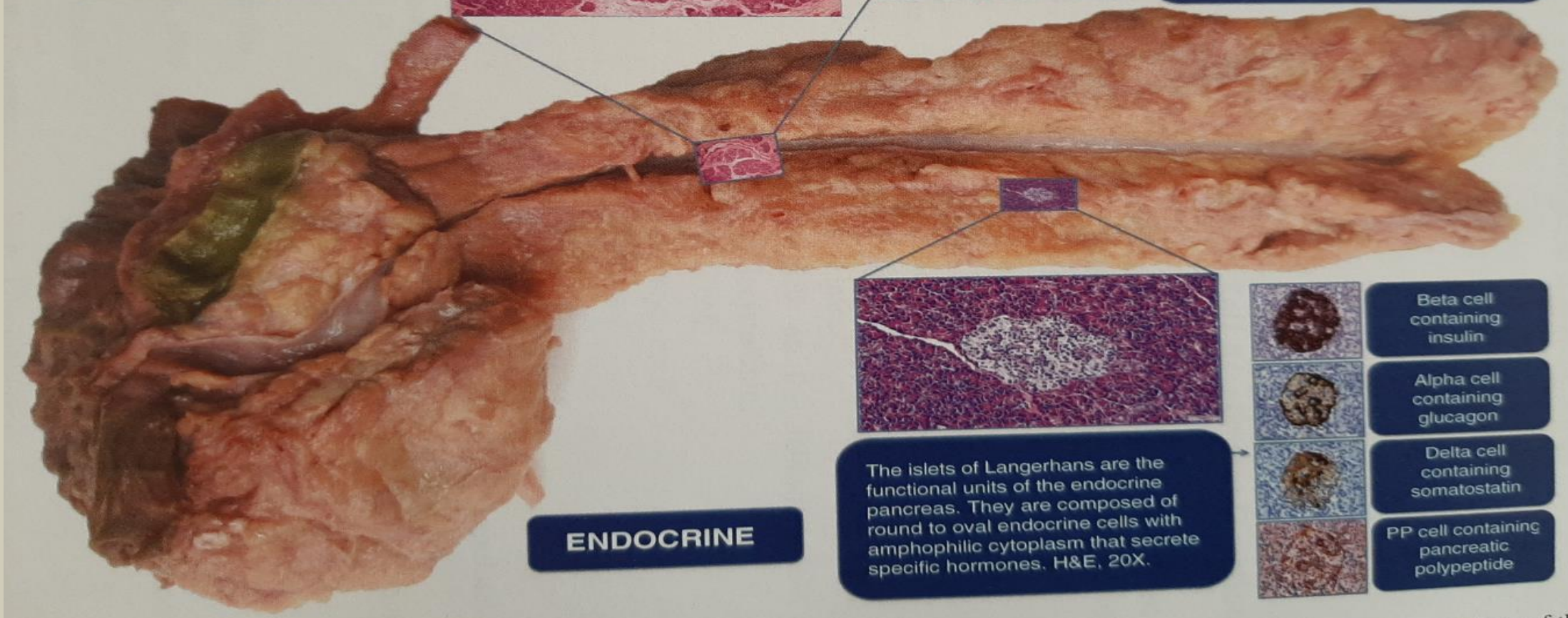
Multiple acinar cells form the acini which is the functional unit of the exocrine pancreas. These pyramidal cells have a basophilic cytoplasm at the base and many eosinophilic granules towards the lumen that secrete zymogens. H&E, 100X.





Small-round centroacinar cells with a pale cytoplasm (glycogen rich) converge to form an intercalated duct. These cells secrete chloride, bicarbonate, and water to buffer and stabilize the zymogens until activation in the duodenum. H&E, 100X.

EXOCRINE



The islets of Langerhans are the functional units of the endocrine pancreas. They are composed of round to oval endocrine cells with amphophilic cytoplasm that secrete specific hormones. H&E, 20X.

Beta cell containing insulin

Alpha cell containing glucagon

Delta cell containing somatostatin

PP cell containing pancreatic polypeptide

ENDOCRINE

portions of the pancreas

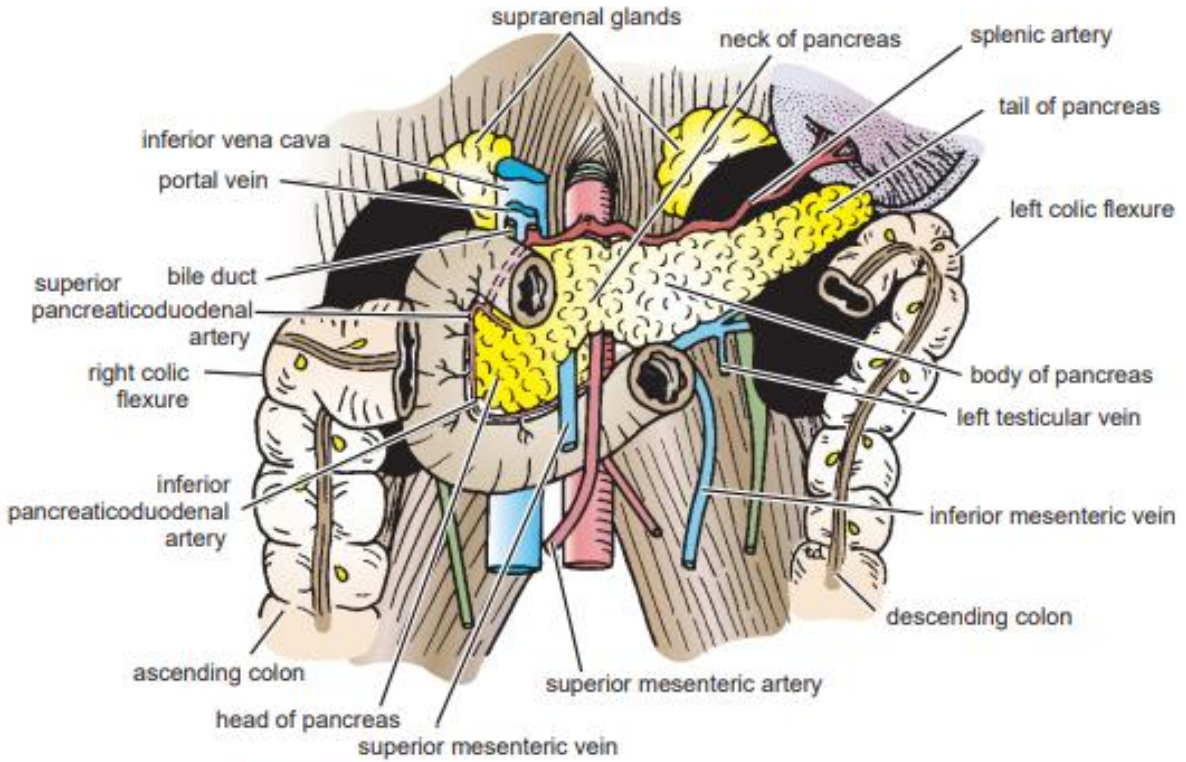


FIGURE 5.26 Pancreas and anterior relations of the kidneys.

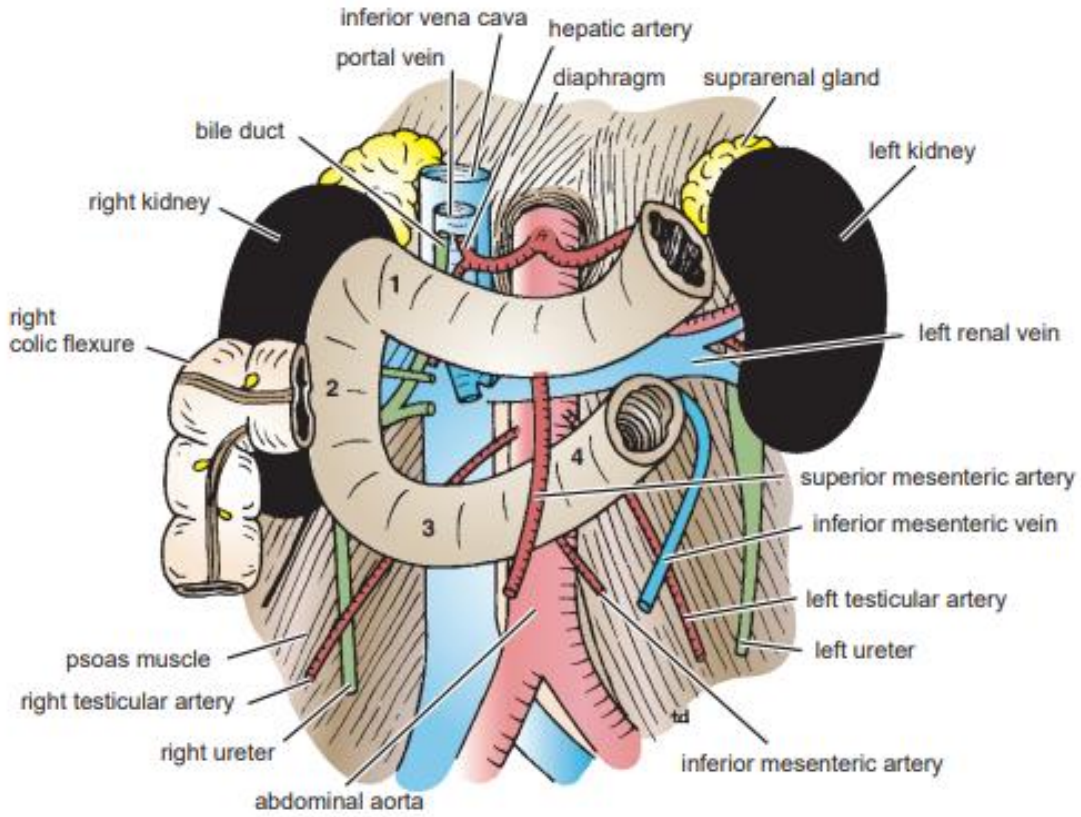


FIGURE 5.27 Posterior relations of the duodenum and the pancreas. The numbers represent the four parts of the duodenum.

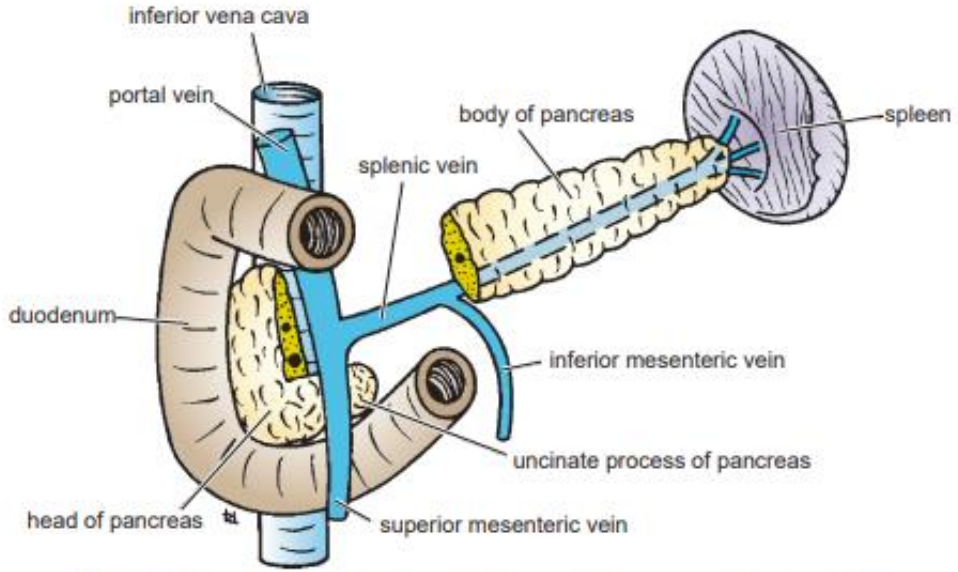


FIGURE 5.48 Formation of the portal vein behind the neck of the pancreas.

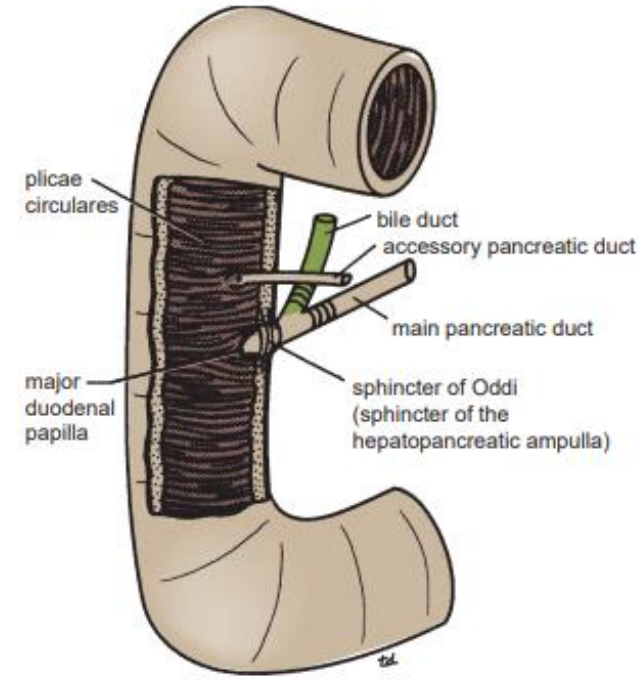


FIGURE 5.51 Terminal parts of the bile and pancreatic ducts as they enter the second part of the duodenum. Note the sphincter of Oddi and the smooth muscle around the ends of the bile duct and the main pancreatic duct.

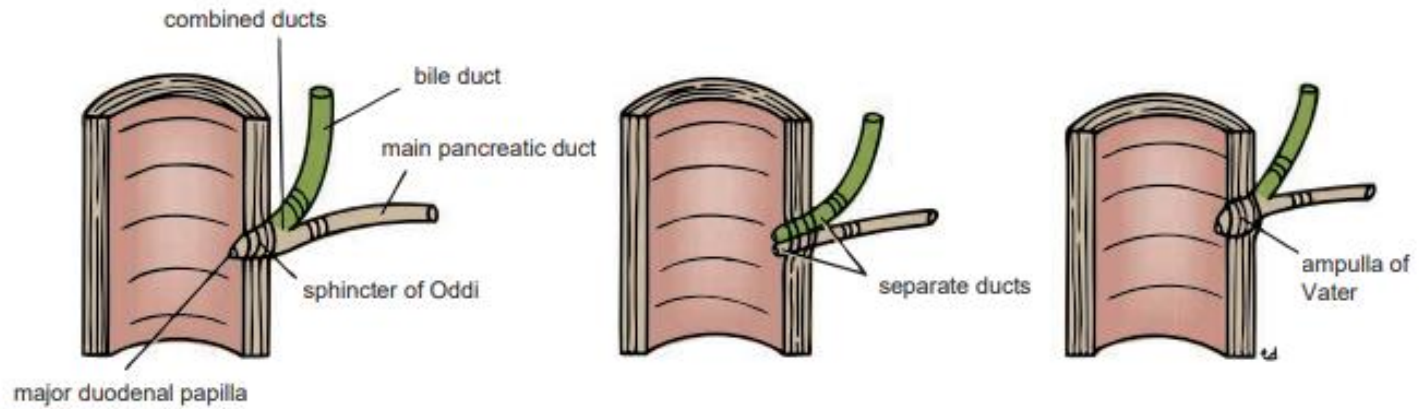


FIGURE 5.52 Three common variations of terminations of the bile and main pancreatic ducts as they enter the second part of the duodenum.

gallbladder. (Figs. 3.4 and 3.11).

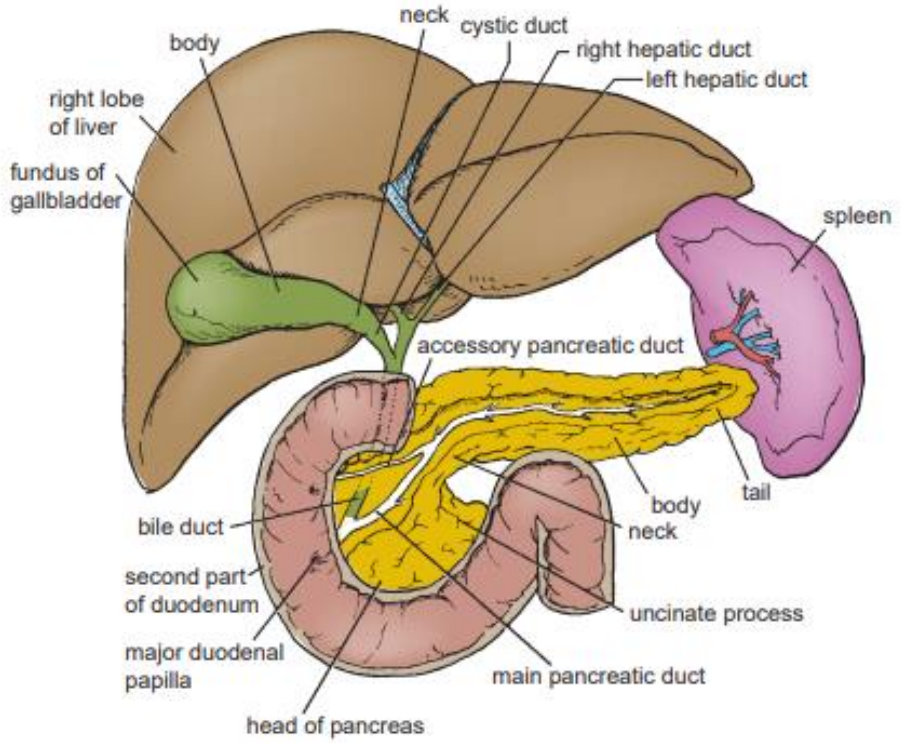
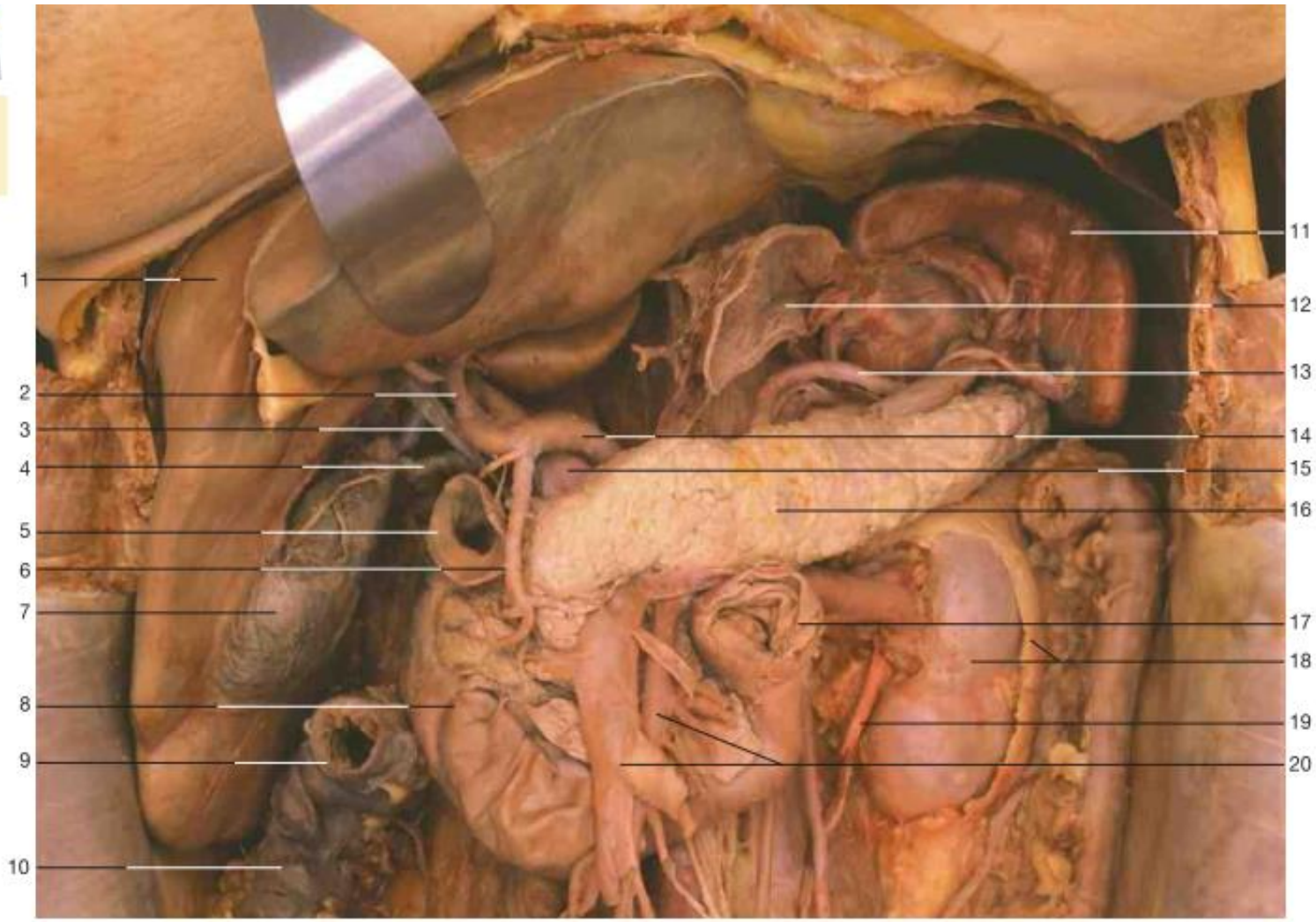
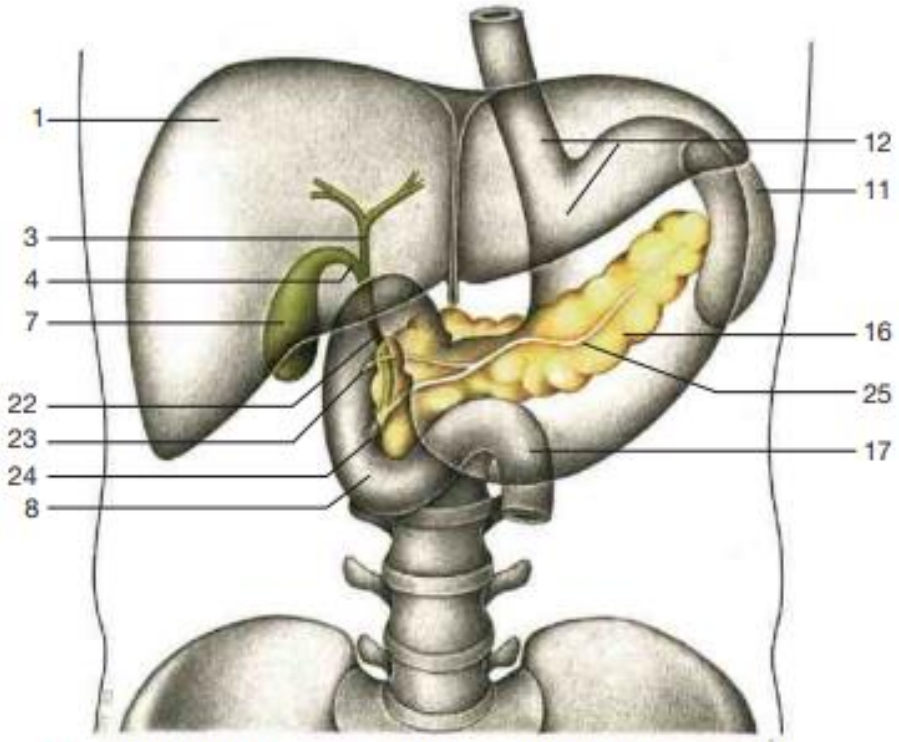


FIGURE 5.58 Different parts of the pancreas dissected to reveal the duct system.

ANATOMICAL DISSECTION CADAVER

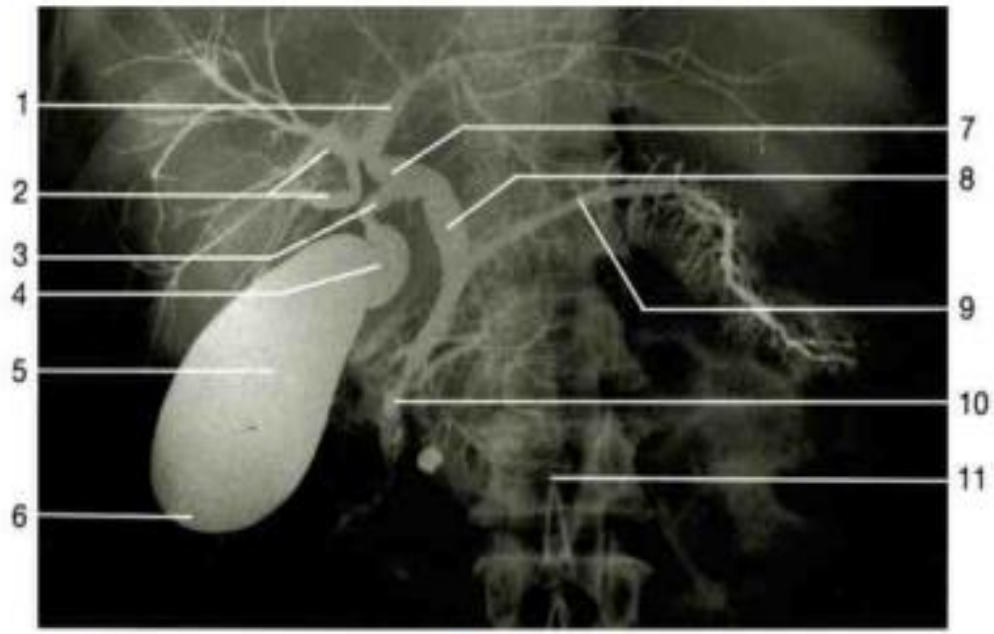


Upper abdominal organs. Pancreas, duodenum, and left kidney are shown. Stomach and transverse colon have been removed, liver elevated; superior mesenteric vein is slightly enlarged.



Pancreas, duodenum, and extrahepatic bile ducts (anterior aspect, schematic drawing).

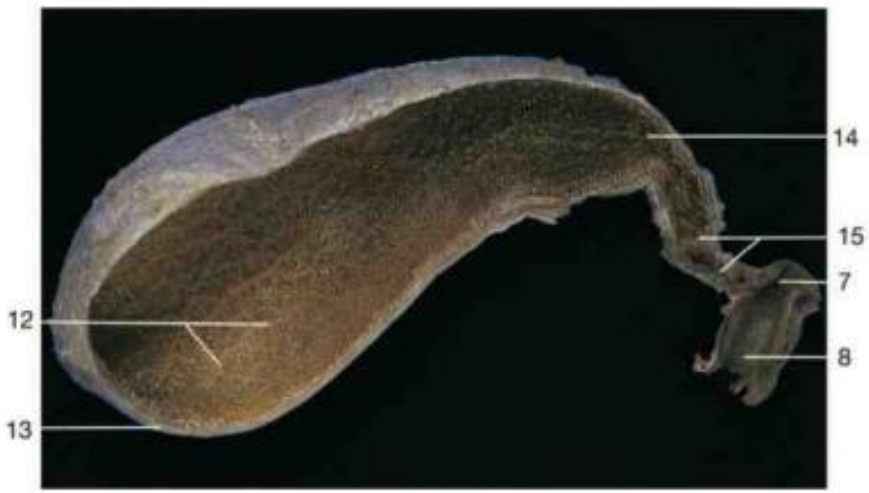
1 Liver
2 Hepatic artery proper
3 Hepatic duct
4 Cystic duct
5 Pylorus
6 Gastroduodenal artery
7 Gallbladder
8 Duodenum
9 Transverse colon (cut)
10 Ascending colon
11 Spleen
12 Cardia
13 Splenic artery
14 Common hepatic artery
15 Portal vein
16 Pancreas (body)
17 Duodenojejunal flexure
18 Kidney (with capsula adiposa)
19 Ureter
20 Superior mesenteric artery and vein
21 Aorta (abdominal part)
22 Common bile duct
23 Lesser duodenal papilla
24 Greater duodenal papilla
25 Pancreatic duct



Radiograph of biliary ducts, gallbladder, and pancreatic duct (antero-posterior view).

1 Left hepatic duct
2 Right hepatic duct
3 Cystic duct
4 Neck of gallbladder
5 Body of gallbladder
6 Fundus of gallbladder
7 Common hepatic duct
8 Common bile duct
9 Pancreatic duct
10 Greater duodenal papilla
11 Second lumbar vertebra
12 Folds of mucous membrane of gallbladder
13 Muscular coat of gallbladder
14 Neck of gallbladder (opened)
15 Cystic duct with spiral fold
16 Lesser duodenal papilla
17 Accessory pancreatic duct
18 Uncinate process
19 Plica circularis of duodenum (Kerckring's fold)
20 Head of pancreas
21 Body of pancreas
22 Tail of pancreas
23 Descending part of duodenum
24 Incisure of pancreas

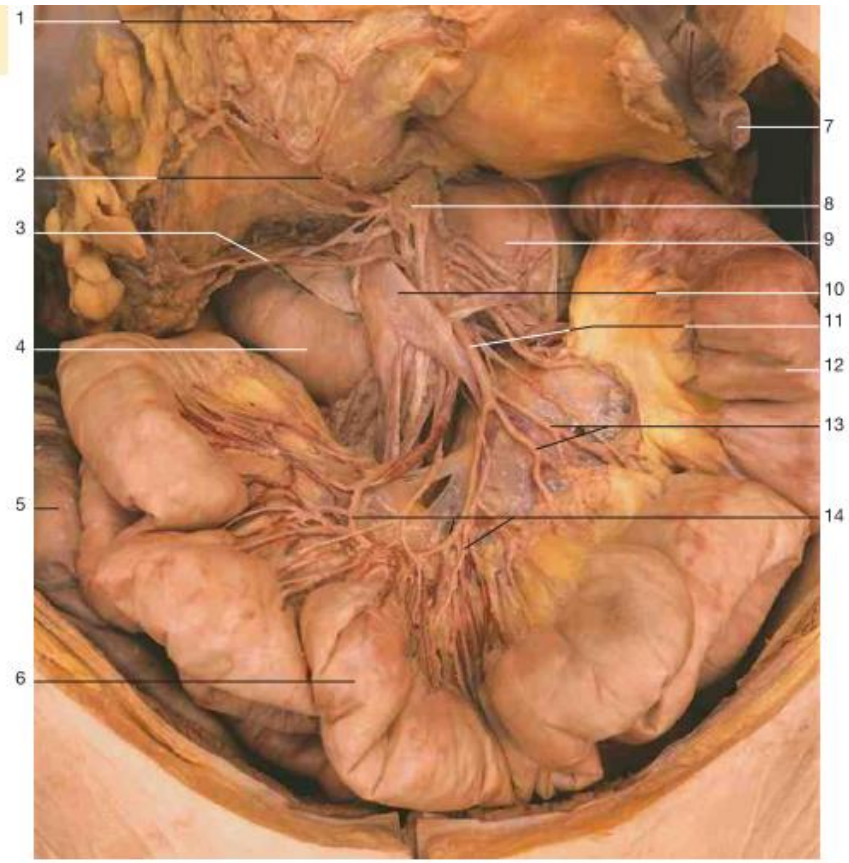
Radiograph of biliary ducts, gallbladder, and pancreatic duct (antero-posterior view).



Isolated gallbladder and cystic duct (anterior aspect).
The gallbladder has been opened to display the mucous membrane.

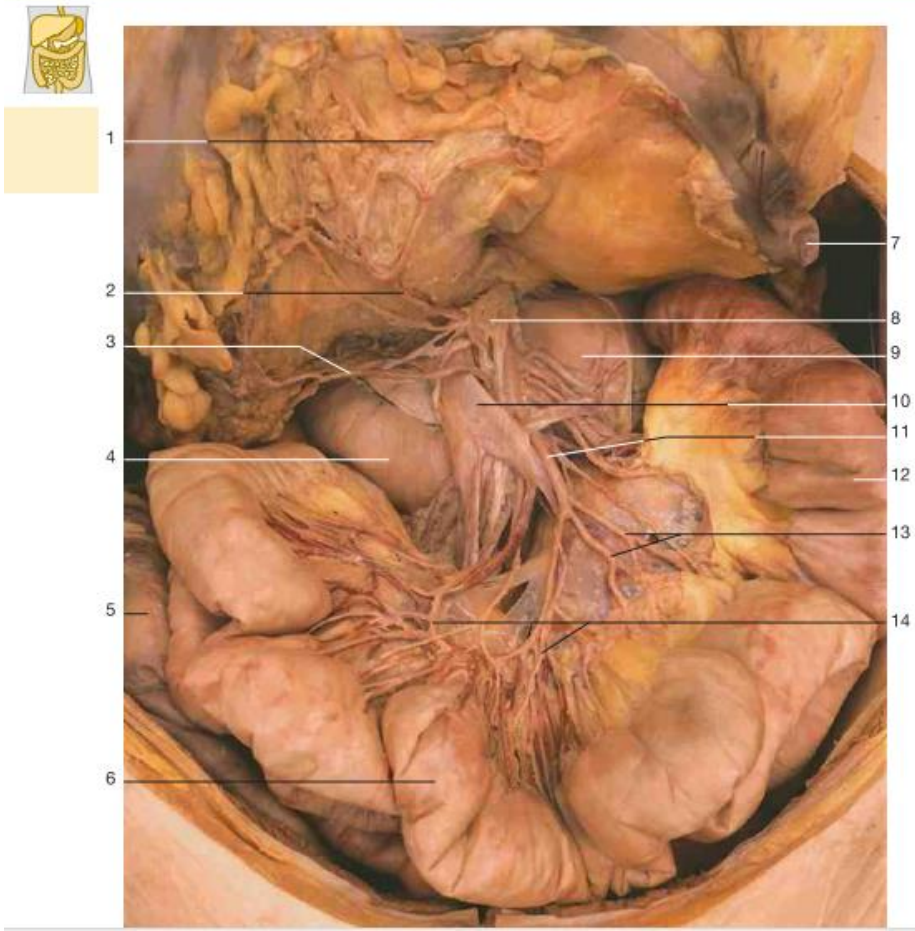
12 Folds of mucous membrane of gallbladder
13 Muscular coat of gallbladder
14 Neck of gallbladder (opened)
15 Cystic duct with spiral fold
16 Lesser duodenal papilla
17 Accessory pancreatic duct
18 Uncinate process
19 Plica circularis of duodenum (Kerckring's fold)
20 Head of pancreas
21 Body of pancreas
22 Tail of pancreas
23 Descending part of duodenum
24 Incisure of pancreas

Pancreas with descending part of duodenum (posterior aspect). The duodenum was opened to display the duodenal papillae. Pancreatic duct has been dissected, the common bile duct has been divided. The sphincter of Oddi is shown.



5 Ascending colon
6 Ileum
7 Transverse colon
8 Celiac ganglion
9 Duodenojejunal flexure
10 Superior mesenteric vein
11 Superior mesenteric artery
12 Jejunum
13 Jejunal arteries
14 Ileal arteries
15 Liver
16 Celiac trunk and abdominal aorta
17 Gallbladder
18 Pancreas
19 Ileocolic artery
20 Stomach
21 Spleen
22 Left colic flexure
23 Appendicular artery
24 Vermiform appendix

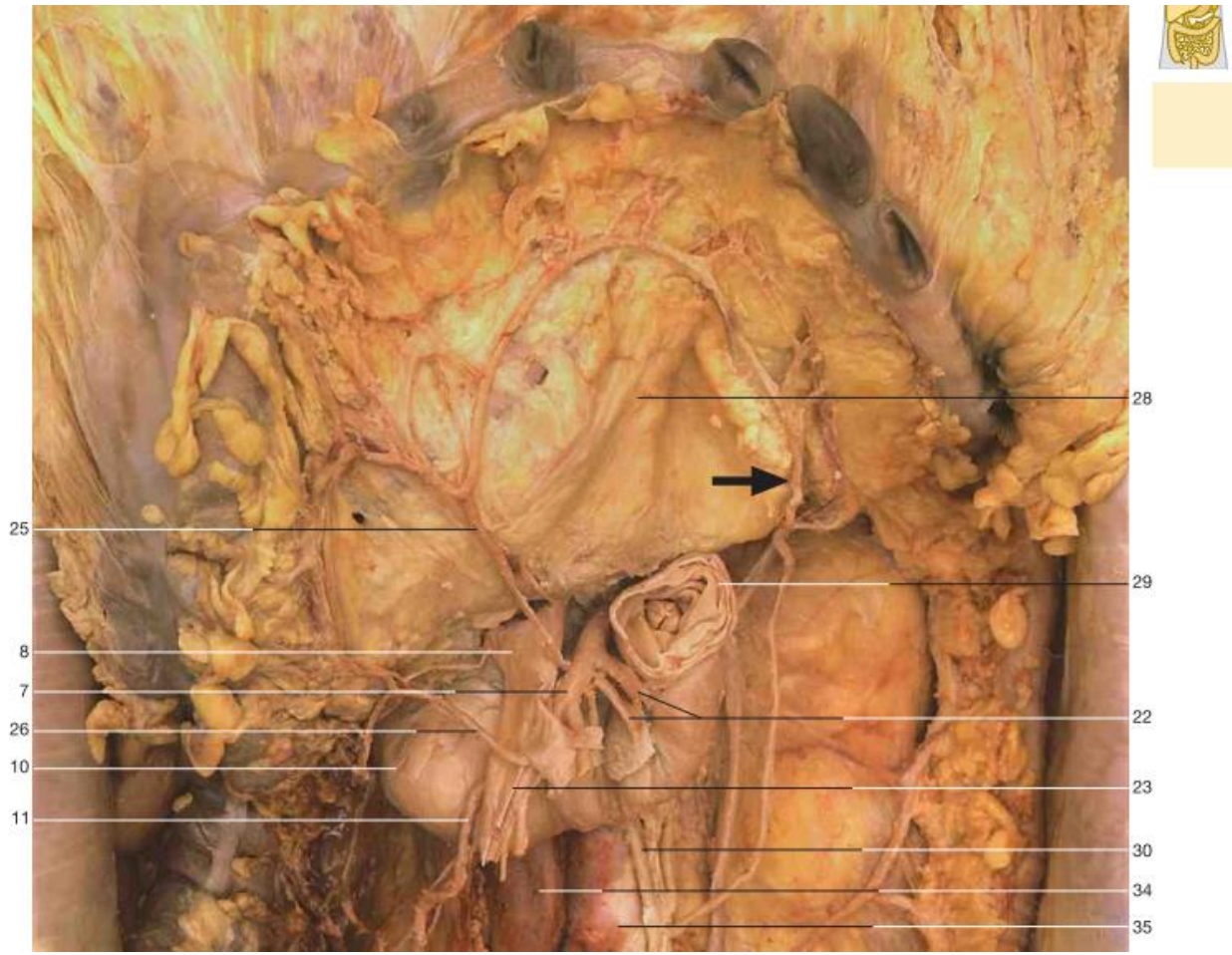
Vessels of abdominal organs, dissection of superior mesenteric artery and vein.
Greater omentum and transverse colon are reflected.



1 Greater omentum
2 Middle colic artery
3 Right colic artery
4 Duodenum
5 Ascending colon
6 Ileum
7 Transverse colon
8 Celiac ganglion
9 Duodenojejunal flexure
10 Superior mesenteric vein
11 Superior mesenteric artery
12 Jejunum
13 Jejunal arteries
14 Ileal arteries
15 Liver
16 Celiac trunk and abdominal aorta
17 Gallbladder
18 Pancreas
19 Ileocolic artery
20 Stomach
21 Spleen
22 Left colic flexure
23 Appendicular artery
24 Vermiform appendix

Superior mesenteric artery in relation to pancreas and duodenum. Stomach and transverse colon have been removed and the liver elevated. Note the location of the spleen. A yellow probe is inserted through the omental foramen.

3 Gallbladder and common bile duct
4 Hepatic artery proper and portal vein
5 Right gastric artery and pylorus
6 Gastroduodenal artery
7 Superior mesenteric artery
8 Superior mesenteric vein
9 Ascending colon
10 Duodenum
11 Ileocolic artery
12 Lymph nodes
13 Ileum
14 Cecum
15 Left lobe of liver
16 Caudate lobe of liver
17 Spleen
18 Left gastric artery
19 Splenic artery
20 Pancreas
21 Left colic flexure (cut)
22 Jejunal arteries
23 Ileal arteries
24 Jejunum
25 Middle colic artery
26 Right colic artery
27 Appendicular artery
28 Transverse mesocolon
29 Duodenojejunal flexure
30 Inferior mesenteric artery
31 Left colic artery
32 Sigmoid arteries
33 Superior rectal artery
34 Inferior vena cava
35 Abdominal aorta
36 Descending colon
37 Ileum
38 Sigmoid colon
39 Vermiform appendix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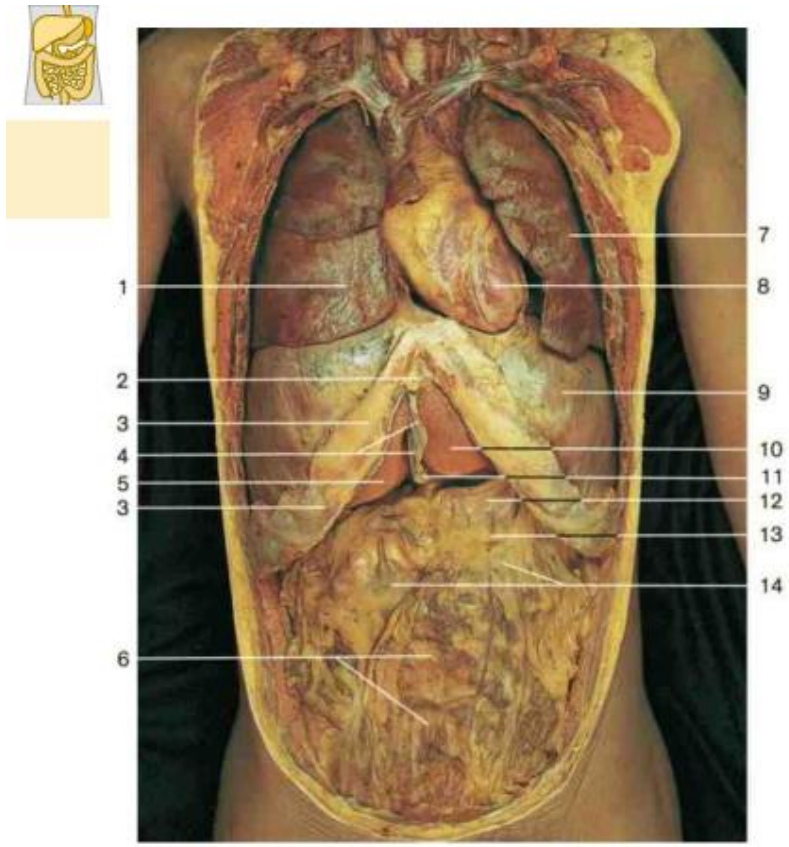
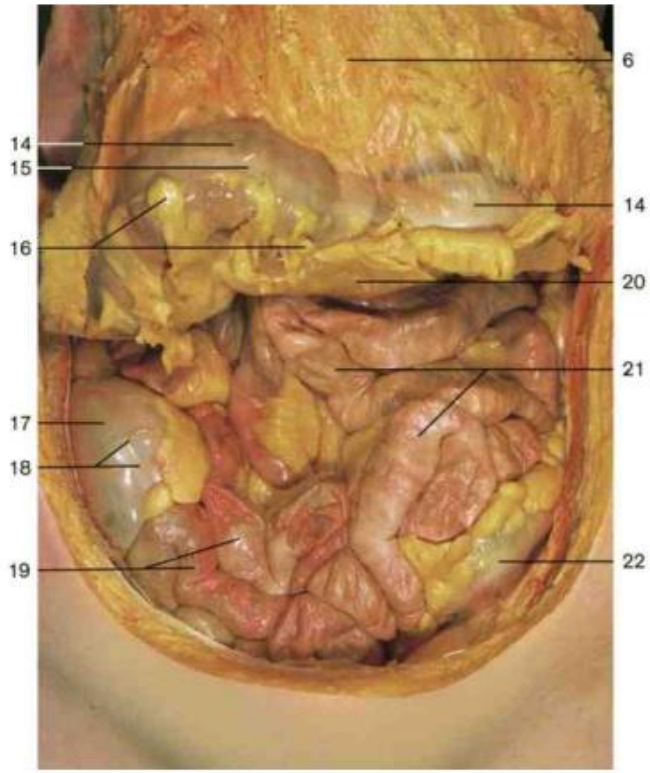
Vessels of the retroperitoneal organs. Direction of the inferior mesenteric artery and its anastomosis with the middle colic artery (arrow = Riolan's anastomosis). Greater omentum and transverse colon have been reflected, the intestine partly removed. The normally retrocecally located vermiform appendix has been replaced anteriorly. The right common iliac artery is partly obstructed by a blood thrombus.

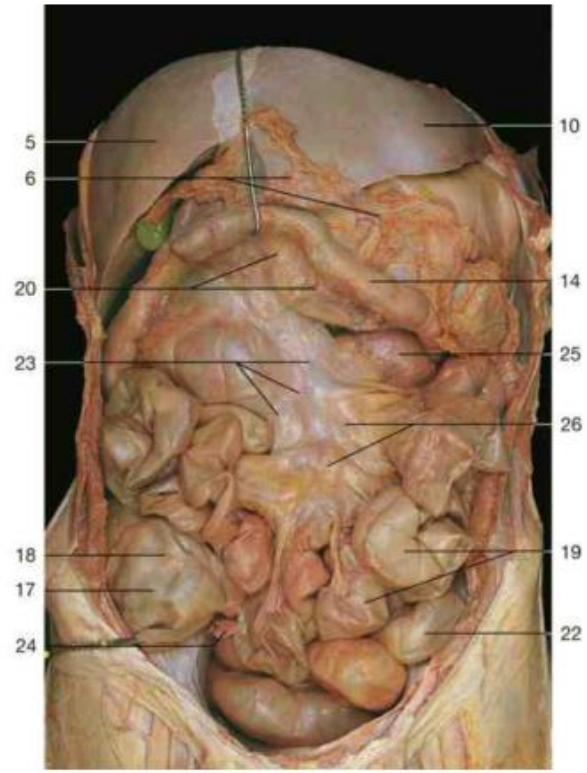


Abdominal organs. The anterior thoracic and abdominal walls have been removed.

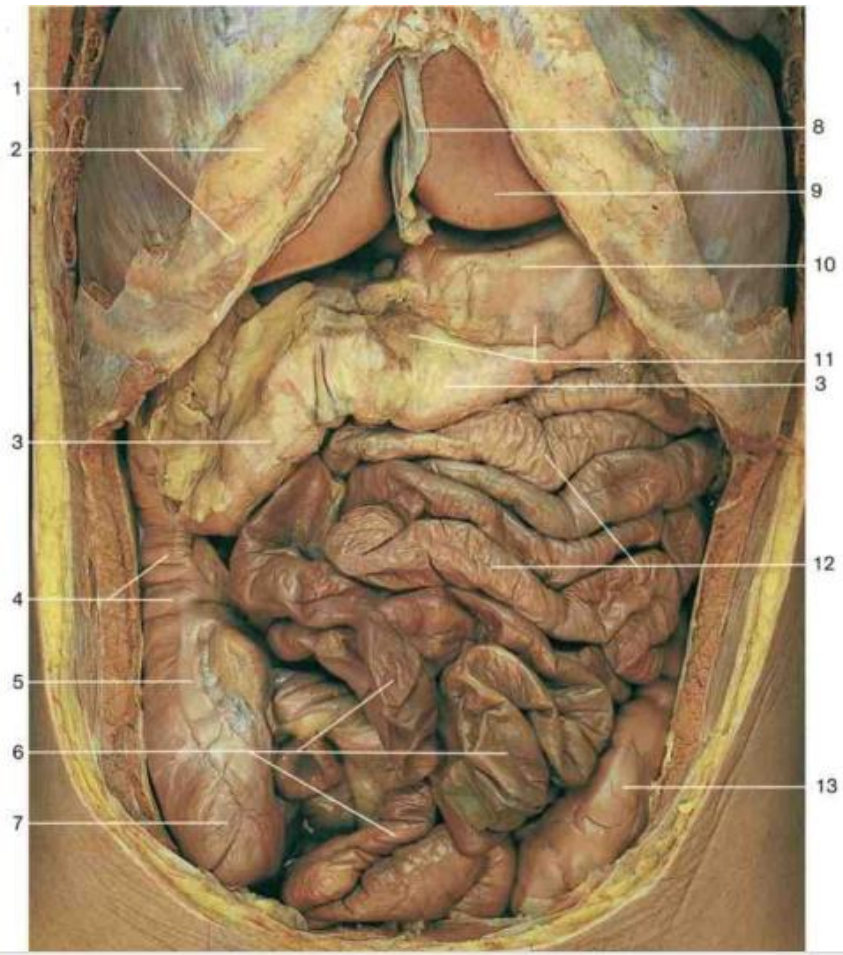
1 Middle lobe of right lung
2 Xiphoid process
3 Costal margin
4 Falciform ligament of liver
5 Quadrate lobe of liver
6 Greater omentum
7 Upper lobe of left lung
8 Heart
9 Diaphragm
10 Left lobe of liver
11 Ligamentum teres
12 Stomach
13 Gastrocolic ligament
14 Transverse colon
15 Taenia coli
16 Appendices epiploicae
17 Cecum
18 Taenia coli
19 Ileum
20 Transverse mesocolon
21 Jejunum
22 Sigmoid colon
23 Position of root of mesentery
24 Vermiform appendix
25 Duodenojejunal flexure
26 Mesentery



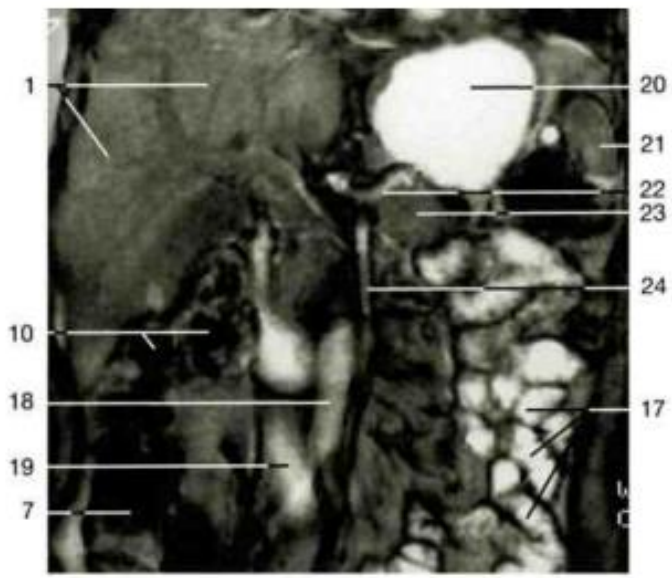
Abdominal organs (anterior aspect). The greater omentum, which is fixed to the transverse colon, has been raised.



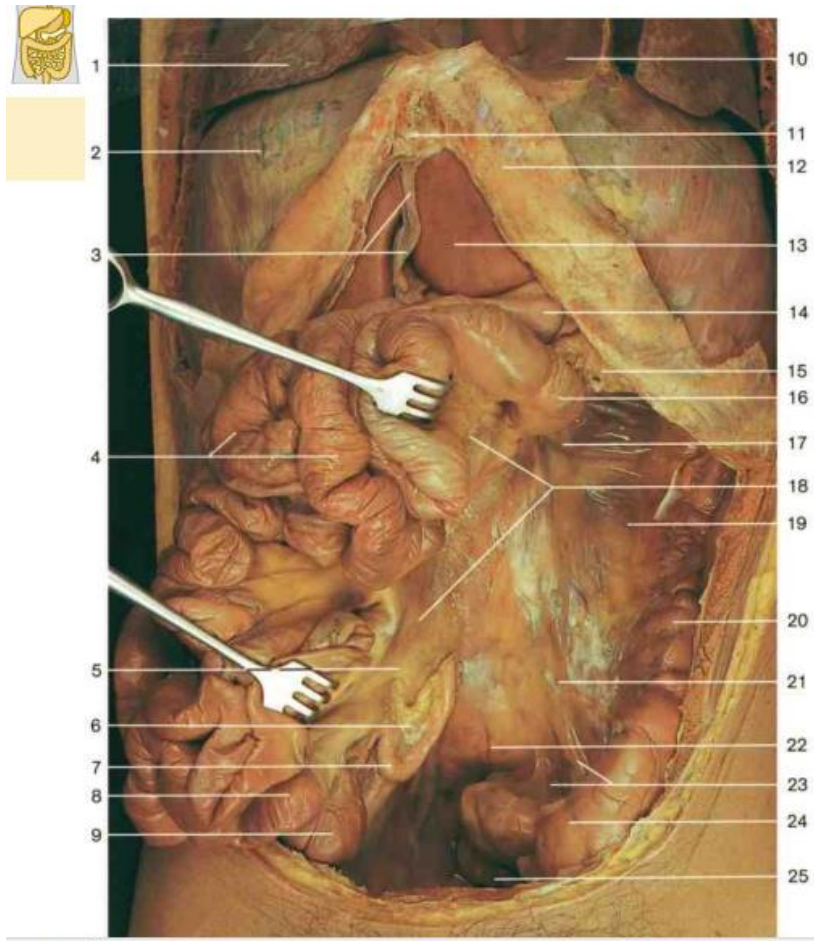
Abdominal organs (anterior aspect). The transverse colon has been reflected.



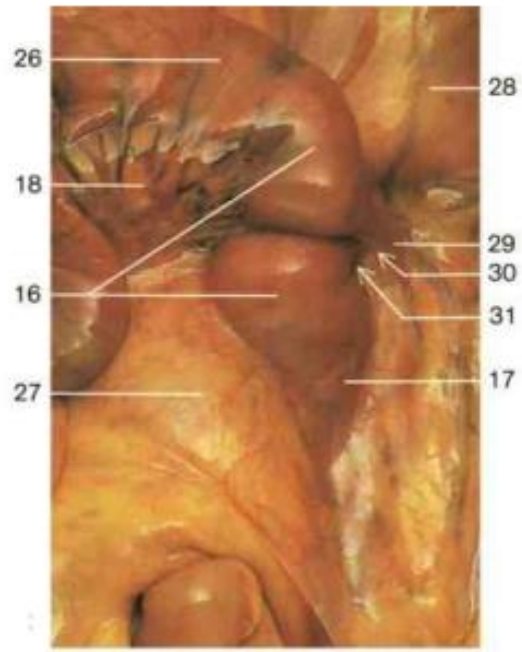
1 Diaphragm
2 Costal margin
3 Transverse colon
4 Ascending colon with haustra
5 Free taenia of cecum
6 Ileum
7 Cecum
8 Falciform ligament of liver
9 Liver
10 Stomach
11 Gastrocolic ligament
12 Jejunum
13 Sigmoid colon
14 Vermiform appendix
15 Terminal ileum
16 Meso-appendix
17 Mesentery



Frontal section through the abdominal cavity (MRI scan; the intestinal tract and vessels are filled with a paramagnetic substance [Gadolinium]; courtesy of Dr. W. Rödl, Erlangen, Germany).



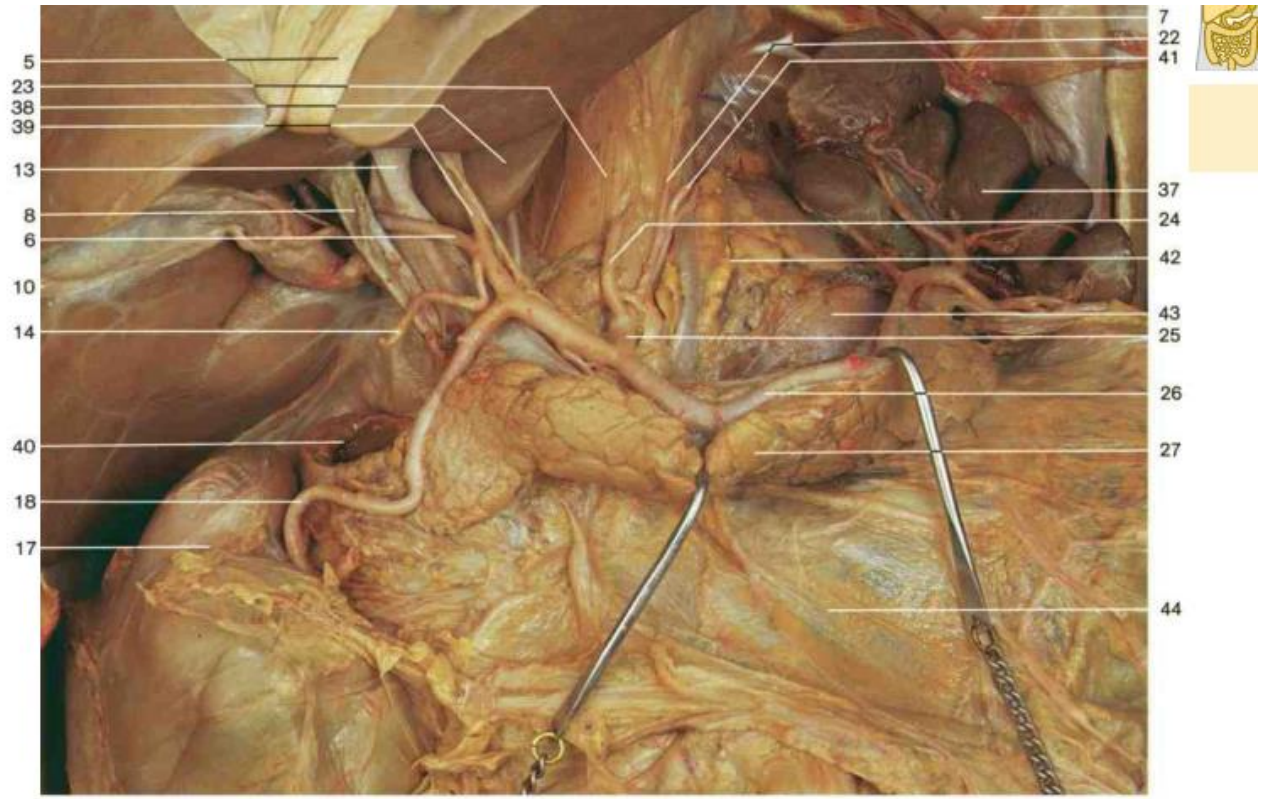
1 Lung
2 Diaphragm
3 Falciform ligament of liver
4 Jejunum
5 Ileocecal fold
6 Meso-appendix
7 Vermiform appendix
8 Ileocecal junction
9 Cecum
10 Pericardial sac
11 Xiphoid process
12 Costal margin
13 Liver
14 Stomach
15 Transverse colon
16 Duodenojejunal flexure
17 Inferior duodenal fold
18 Mesentery
19 Position of left kidney
20 Descending colon
21 Position of left common iliac artery
22 Sacral promontory
23 Sigmoid mesocolon
24 Sigmoid colon
25 Rectum
26 Beginning of jejunum
27 Peritoneum of posterior abdominal wall
28 Transverse mesocolon
29 Superior duodenal fold
30 Superior duodenal recess
31 Retroduodenal recess
32 Free taenia of ascending colon
33 Ileocecal valve
34 Frenulum of ileocecal valve
35 Orifice of vermiform appendix (probe)
36 Ileocolic artery
37 Vermiform appendix with appendicular artery



Duodenojejunal flexure
(enlargement of preceding figure).

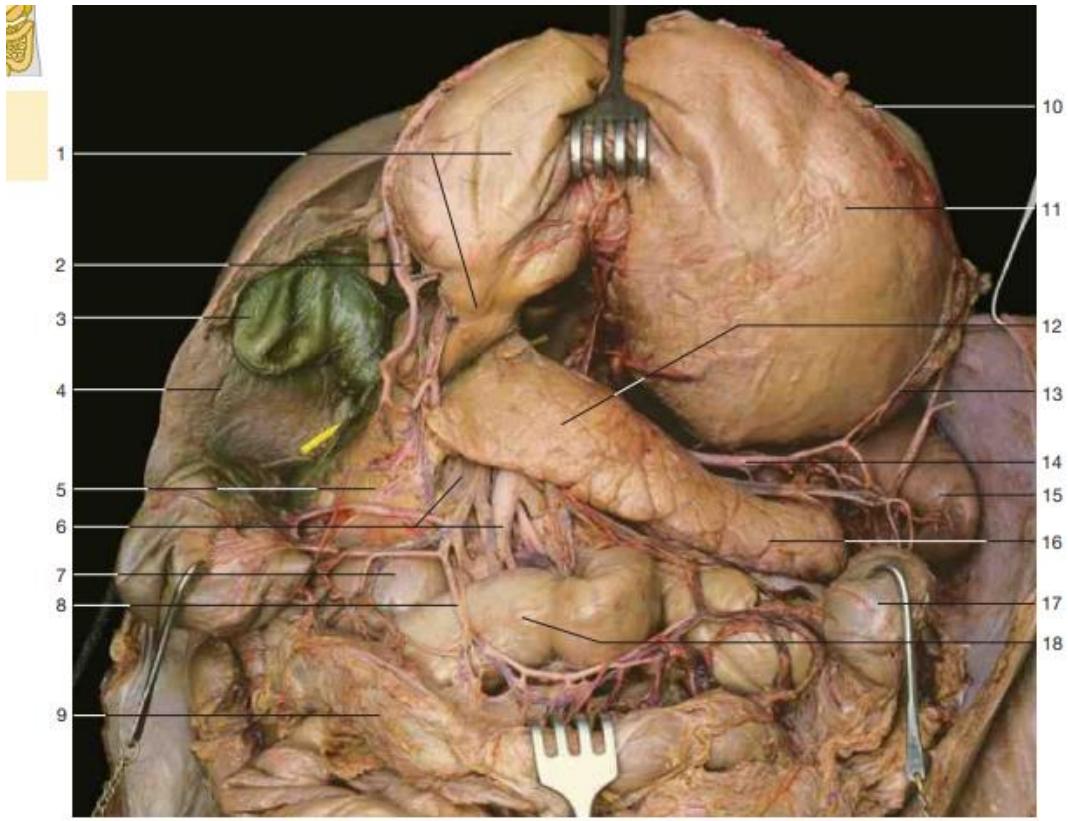
Ileocecal valve (ventral aspect). The cecum and terminal part of the ileum have been opened.

1 Falciform ligament and ligamentum teres
2 Liver
3 Hepatoduodenal ligament
4 Gallbladder
5 Probe within the epiploic foramen
6 Superior part of duodenum
7 Pylorus
8 Descending part of duodenum
9 Right colic flexure
10 Gastrocolic ligament
11 Greater omentum
12 Caudate lobe of liver
13 Fundus of stomach
14 Probe at the level of the vestibule of lesser sac (through epiploic foramen)
15 Head of pancreas
16 Lesser curvature of stomach
17 Body of stomach
18 Diaphragm
19 Greater curvature with gastro-omental vessels
20 Head of pancreas and gastropancreatic fold
21 Spleen
22 Tail of pancreas
23 Left colic flexure
24 Root of transverse mesocolon
25 Transverse mesocolon
26 Gastrocolic ligament (cut edge)
27 Transverse colon
28 Umbilicus
29 Small intestine
30 Lesser omentum
31 Lesser sac (omental bursa)
32 Duodenum
33 Mesentery
34 Sigmoid colon



Arteries of upper abdominal organs (anterior aspect). **Branches of celiac trunk; blood supply of liver, pancreas, and spleen.** The stomach, superior part of duodenum, and celiac ganglion have been removed to reveal the anterior aspect of the posterior wall of the lesser sac (omental bursa) and the vessels and ducts of the hepatoduodenal ligament. The pancreas has been slightly reflected anteriorly.

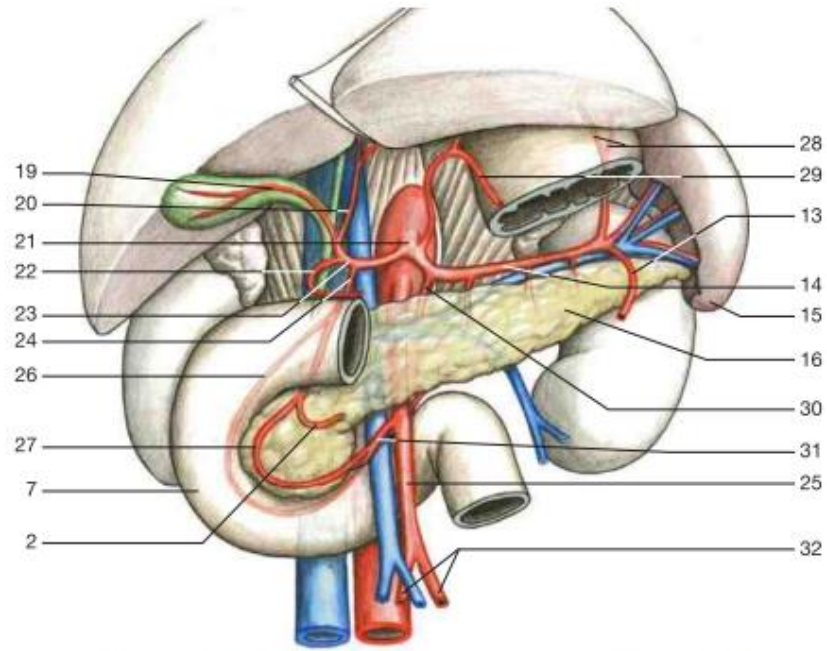
1 Lung
2 Liver (visceral surface)
3 Lymph node
4 Inferior vena cava
5 Ligamentum teres (reflected)
6 Right branch of hepatic artery proper
7 Diaphragm
8 Common hepatic duct (dilated)
9 Cystic duct and artery
10 Gallbladder
11 Probe in epiploic foramen
12 Right lobe of liver
13 Portal vein
14 Right gastric artery
15 Duodenum
16 Pylorus
17 Right colic flexure
18 Right gastro-omental (gastro-epiploic) artery
19 Transverse colon
20 Abdominal part of esophagus (cardiac part of stomach)
21 Fundus of stomach
22 Esophageal branches of left gastric artery
23 Lumbar part of diaphragm
24 Left gastric artery
25 Celiac trunk
26 Splenic artery
27 Pancreas
28 Common hepatic artery
29 Left gastro-omental (gastro-epiploic) artery
30 Gastroduodenal artery
31 Pyloric part of stomach
32 Greater curvature of stomach
33 Gastrocolic ligament
34 Superior pancreaticoduodenal artery
35 Short gastric arteries
36 Aorta
37 Spleen
38 Caudate lobe of liver
39 Left branch of hepatic artery proper
40 Descending part of duodenum (cut)
41 Left inferior phrenic artery
42 Suprarenal gland
43 Kidney
44 Transverse mesocolon



Posterior abdominal wall with pancreas and extrahepatic bile ducts in situ (anterior aspect). The gastrocolic ligament has been divided, the transverse colon and the stomach replaced to display the pancreas and superior mesenteric vessels.

1 Stomach (pyloric part) and pylorus
2 Right gastro-omental (gastro-epiploic) artery

replaced to display the pancreas and superior mesenteric vessels.

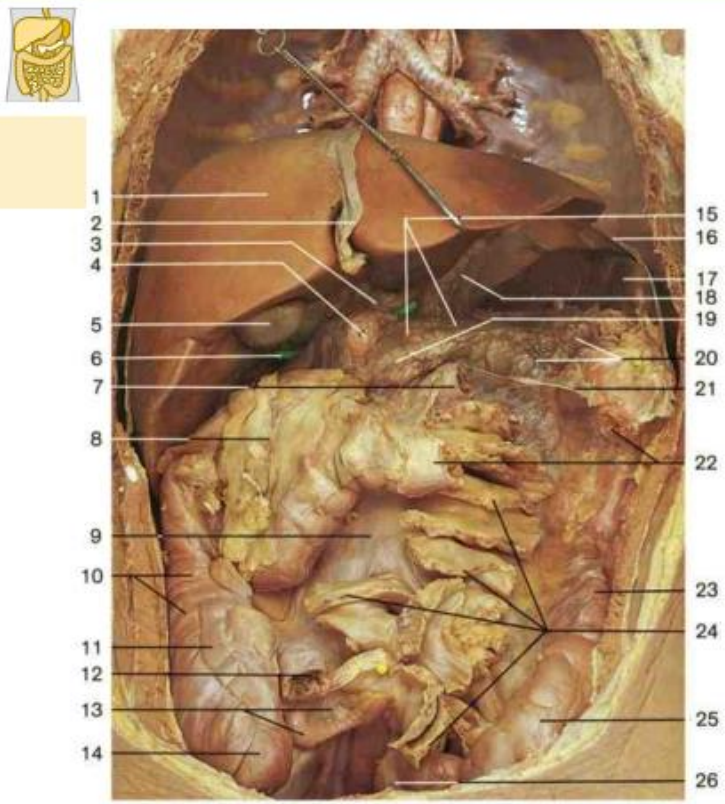


Blood supply of upper abdominal organs (branches of the celiac trunk and superior mesenteric artery). (Schematic drawing.)

1 Stomach (pyloric part) and pylorus
2 Right gastro-omental (gastro-epiploic) artery
3 Fundus of gallbladder
4 Liver (right lobe)
5 Head of pancreas
6 Superior mesenteric artery and vein
7 Duodenum
8 Middle colic artery
9 Transverse colon
10 Greater curvature of stomach (remnants of gastrocolic ligament)
11 Body of stomach
12 Body of pancreas
13 Left gastro-omental (gastro-epiploic) artery
14 Splenic artery
15 Spleen
16 Tail of pancreas
17 Left colic flexure
18 Jejunum
19 Cystic artery
20 Hepatic artery proper
21 Celiac trunk
22 Right gastric artery
23 Common hepatic artery
24 Gastroduodenal artery
25 Superior mesenteric artery
26 Superior posterior pancreaticoduodenal artery
27 Superior anterior pancreaticoduodenal artery
28 Short gastric arteries
29 Left gastric artery
30 Posterior pancreatic branch of splenic artery
31 Inferior pancreaticoduodenal artery
32 Jejunal arteries

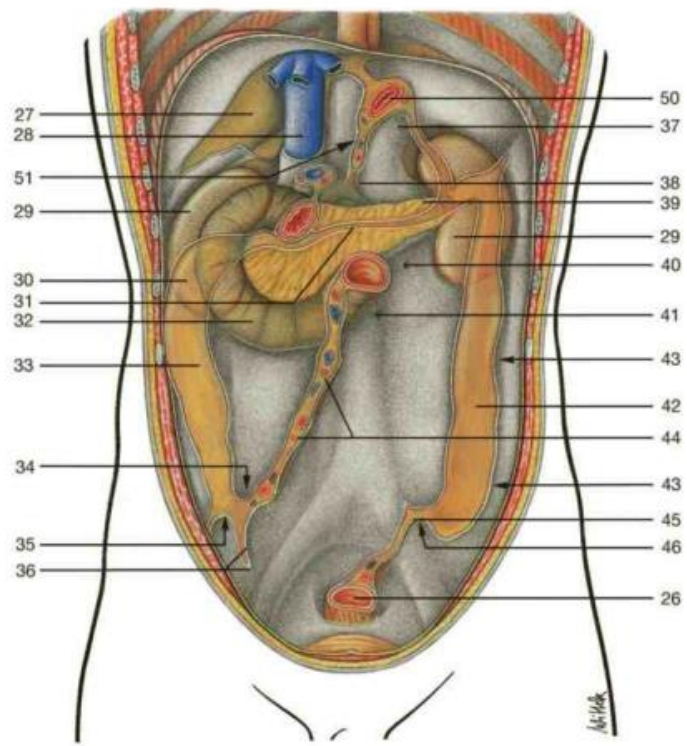
Posterior abdominal wall with duodenum, pancreas, and spleen (anterior aspect). Dissection of pancreatic and common bile duct. The stomach has been removed, the liver raised, and the duodenum anteriorly opened.

1 Ligamentum teres
2 Gallbladder and cystic artery
3 Common hepatic duct and portal vein
4 Cystic duct
5 Right gastric artery (pylorus with superior part of duodenum, cut and reflected)
6 Gastroduodenal artery
7 Common bile duct
8 Probe within the minor duodenal papilla
9 Accessory pancreatic duct
10 Probe within the major duodenal papilla
11 Descending part of duodenum (opened)
12 Middle colic artery and inferior pancreaticoduodenal artery
13 Horizontal part of duodenum (distended)
14 Superior mesenteric artery
15 Liver (left lobe)
16 Caudate lobe of liver and hepatic artery proper
17 Abdominal part of esophagus (cut)
18 Probe in epiploic foramen and lymph node
19 Left gastric artery
20 Spleen
21 Splenic vein and branches of splenic artery
22 Main pancreatic duct and head of pancreas
23 Left colic flexure and tail of pancreas
24 Duodenojejunal flexure



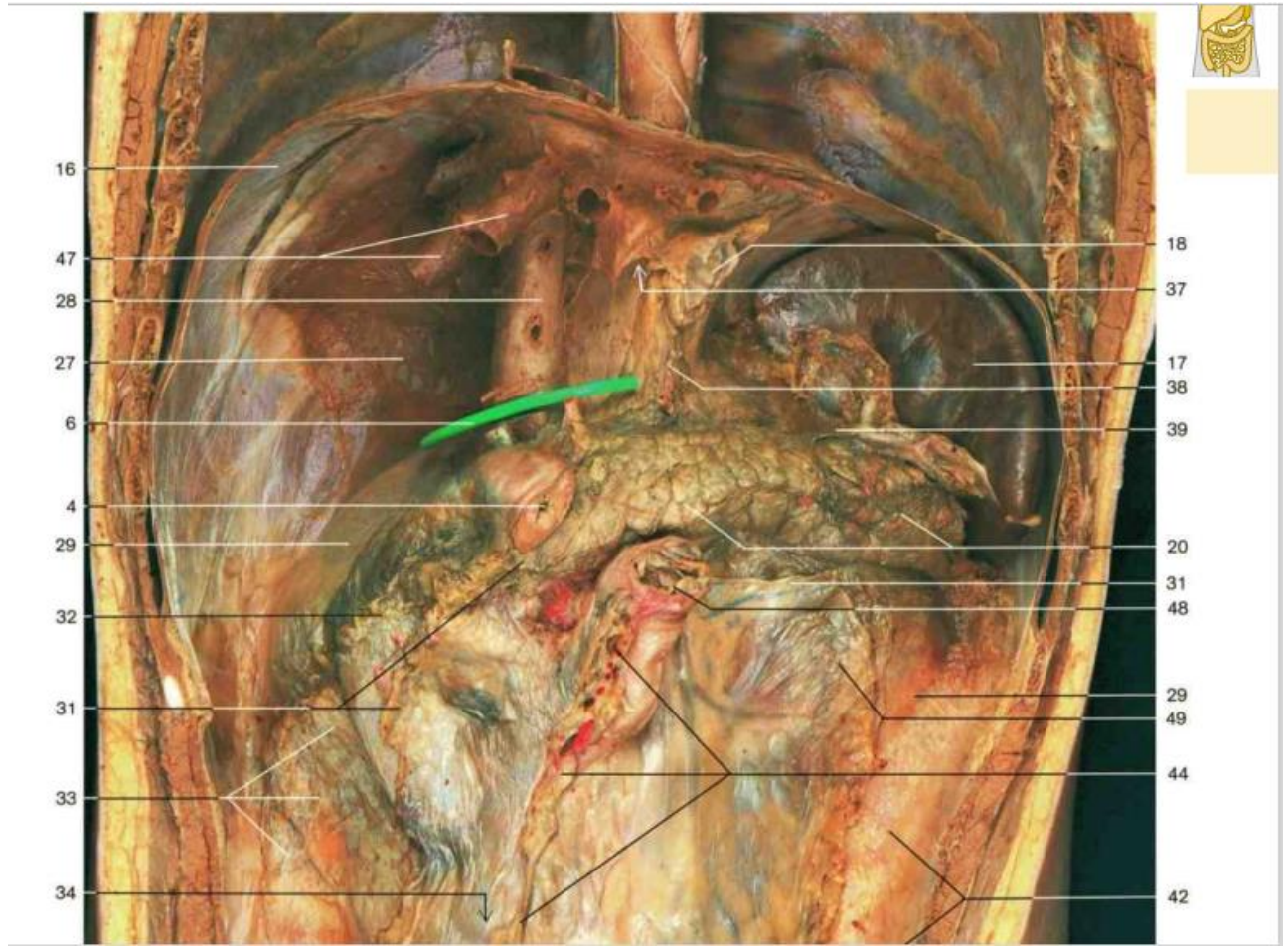
Abdominal cavity after removal of stomach, jejunum, ileum, and part of the transverse colon. Liver has been slightly raised.

1 Liver
2 Falciform ligament
3 Hepatoduodenal ligament
4 Pylorus (divided)
5 Gallbladder
6 Probe within the epiploic foramen
7 Duodenojejunal flexure (divided)
8 Greater omentum
9 Root of mesentery
10 Ascending colon
11 Free colic taenia
12 End of ileum (divided)
13 Vermiform appendix with meso-appendix
14 Cecum
15 Pancreas and site of lesser sac
16 Diaphragm
17 Spleen
18 Cardia (part of stomach, divided)
19 Head of pancreas
20 Body and tail of pancreas
21 Transverse mesocolon
22 Transverse colon (divided)
23 Descending colon
24 Cut edge of mesentery
25 Sigmoid colon
26 Rectum
27 Attachment of bare area of liver
28 Inferior vena cava
29 Kidney
30 Attachment of right colic flexure
31 Root of transverse mesocolon
32 Junction between descending and horizontal parts of duodenum
33 Bare surface for ascending colon
34 Ileocecal recess
35 Retrocecal recess



34 Ileocecal recess
35 Retrocecal recess
36 Root of meso-appendix
37 Superior recess
38 Isthmus (opening)
39 Splenic recess
} of lesser sac (omental bursa)
40 Superior duodenal recess
41 Inferior duodenal recess
42 Bare surface for descending colon
43 Paracolic recesses
44 Root of mesentery
45 Root of mesosigmoid
46 Intersigmoid recess
47 Hepatic veins
48 Duodenojejunal flexure
49 Attachment of left colic flexure
50 Esophagus
51 Entrance to lesser sac through the epiploic foramen

Peritoneal reflections from organs and the position of root of mesentery and peritoneal recesses on the posterior abdominal wall (schematic drawing).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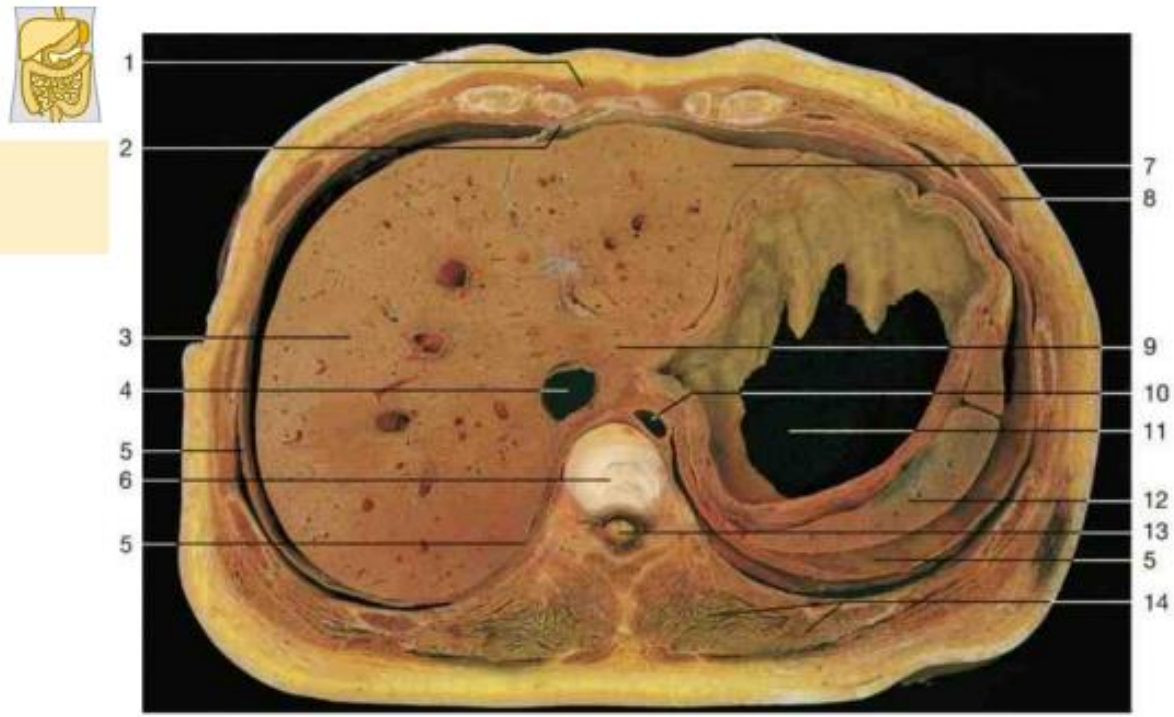
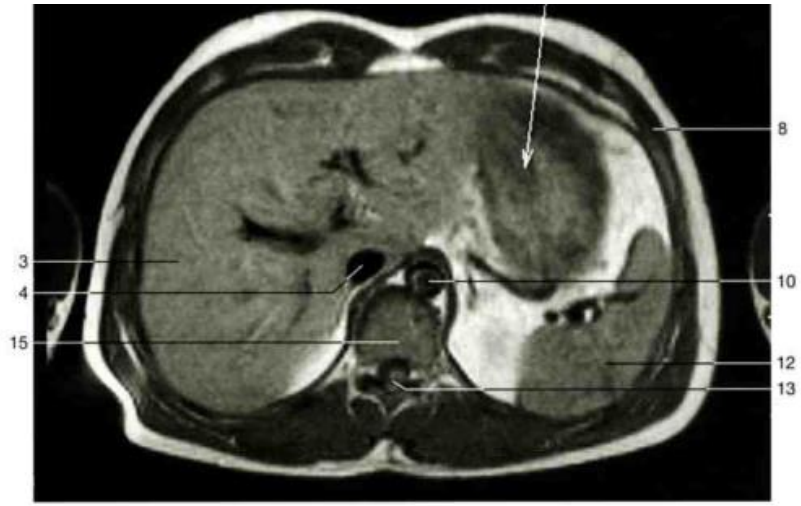
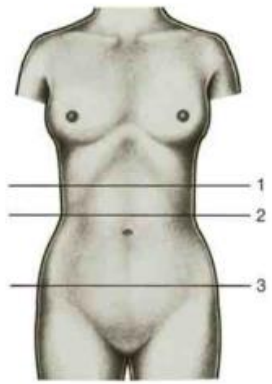


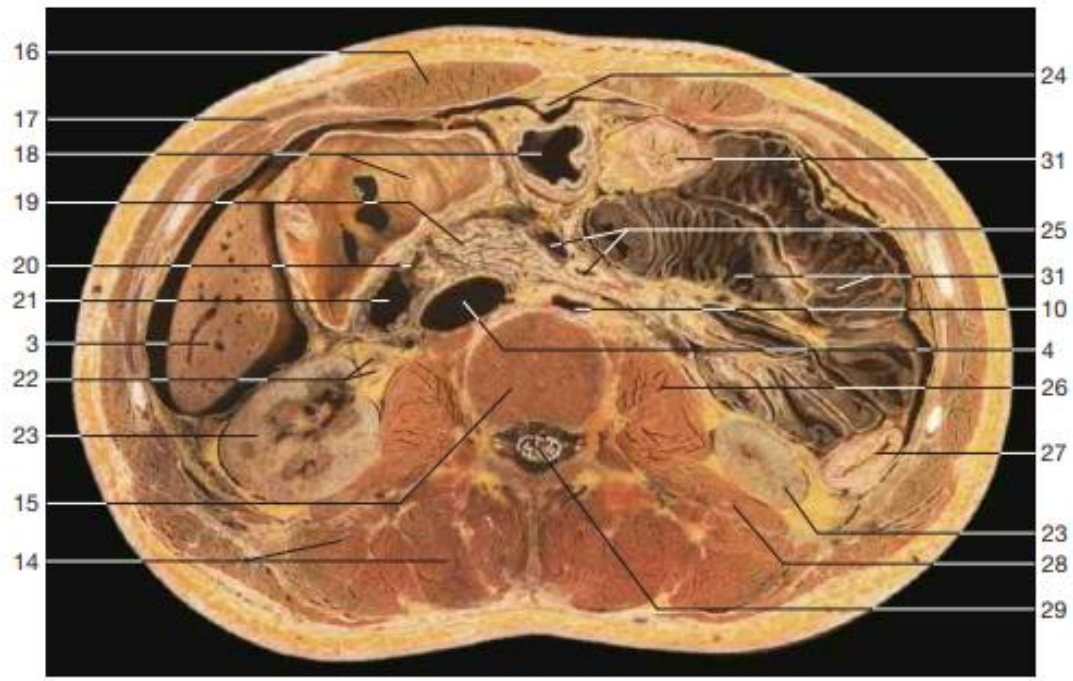
Horizontal section through the abdominal cavity
at level 1 (from below).



Horizontal section through the abdominal cavity (MRI scan, corresponding to level 1). Arrow: stomach.

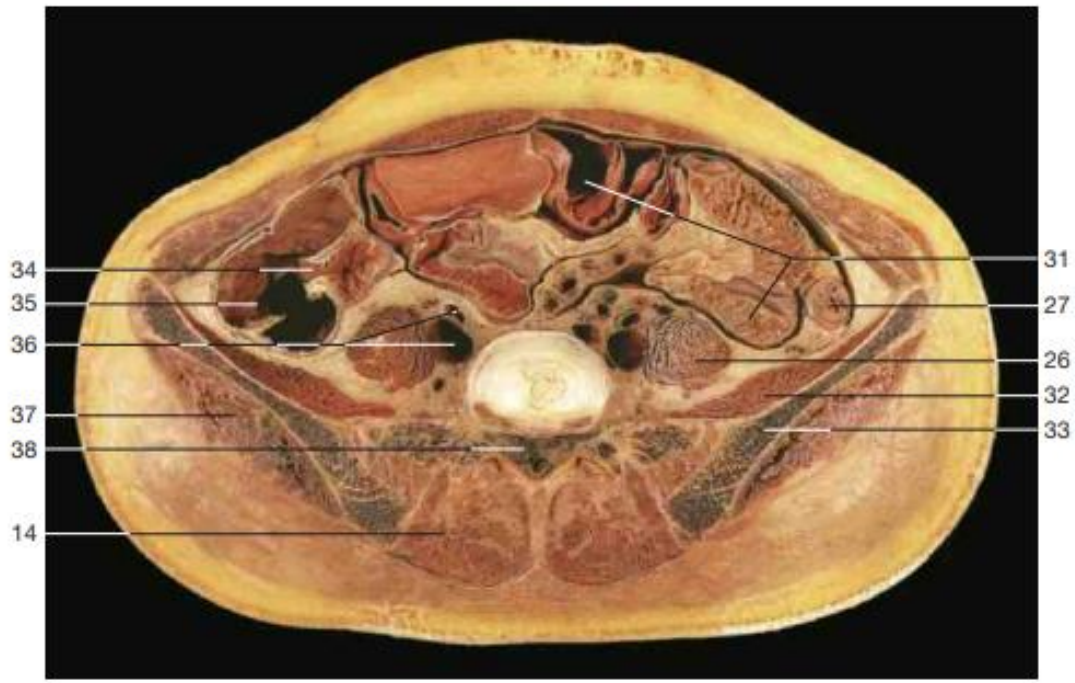


1 Rectus abdominis muscle
2 Falciform ligament
3 Liver (right lobe)
4 Inferior vena cava
5 Diaphragm
6 Intervertebral disc
7 Liver (left lobe)
8 Rib
9 Liver (caudate lobe)
10 Abdominal (descending) aorta
11 Stomach
12 Spleen
13 Spinal cord
14 Longissimus and iliocostalis muscles
15 Body of vertebra
16 Rectus abdominis muscle
20 Greater duodenal papilla
21 Duodenum
22 Suprarenal gland and ureter
23 Kidney
24 Round ligament of liver
25 Superior mesenteric artery and vein
26 Psoas major muscle
27 Descending colon
28 Quadratus lumborum muscle
29 Cauda equina
30 Right renal vein
31 Small intestine
32 Iliacus muscle
33 Ilium
34 Ileocecal valve
35 Cecum

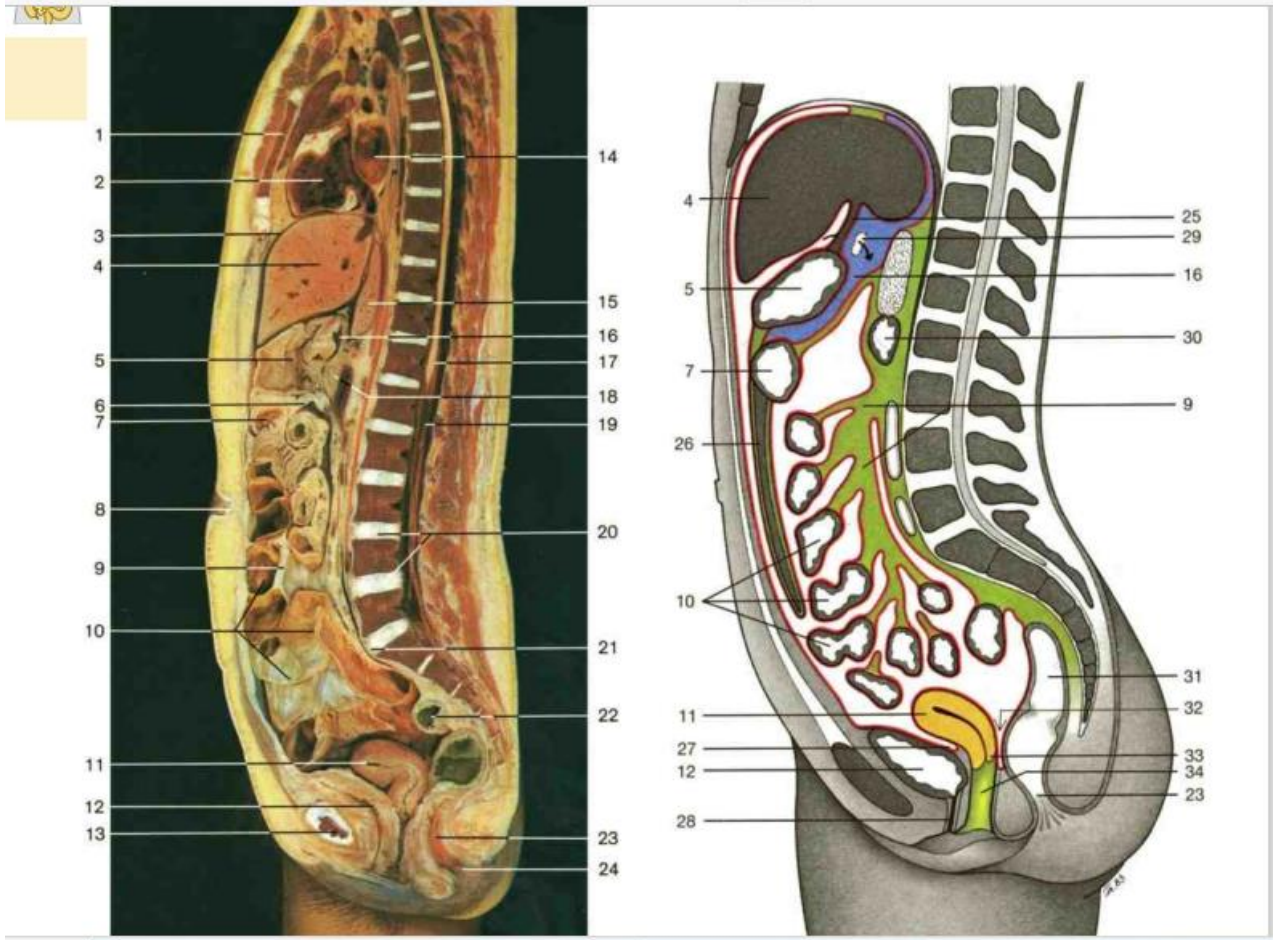


Horizontal section through the abdominal cavity at the level of greater duodenal papilla (from below).

Horizontal section through the abdominal cavity (CT scan, corresponding to level 2).



Horizontal section through the abdominal cavity
at level 3 (from below).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1 Sternum
2 Right ventricle of heart
3 Diaphragm
4 Liver
5 Stomach
6 Transverse mesocolon
7 Transverse colon
8 Umbilicus
9 Mesentery
10 Small intestine
11 Uterus
12 Urinary bladder
13 Pubic symphysis
14 Left atrium of heart
15 Caudate lobe of liver
16 Omental bursa or lesser sac
17 Conus medullaris
18 Pancreas
19 Cauda equina
20 Intervertebral discs (lumbar vertebral column)
21 Sacral promontory
22 Sigmoid colon
23 Anal canal
24 Anus
25 Lesser omentum
26 Greater omentum
27 Vesico-uterine pouch
28 Urethra
29 Epiploic (omental) foramen
30 Duodenum
31 Rectum
32 Recto-uterine pouch
33 Vaginal part of cervix of uterus
34 Vagina

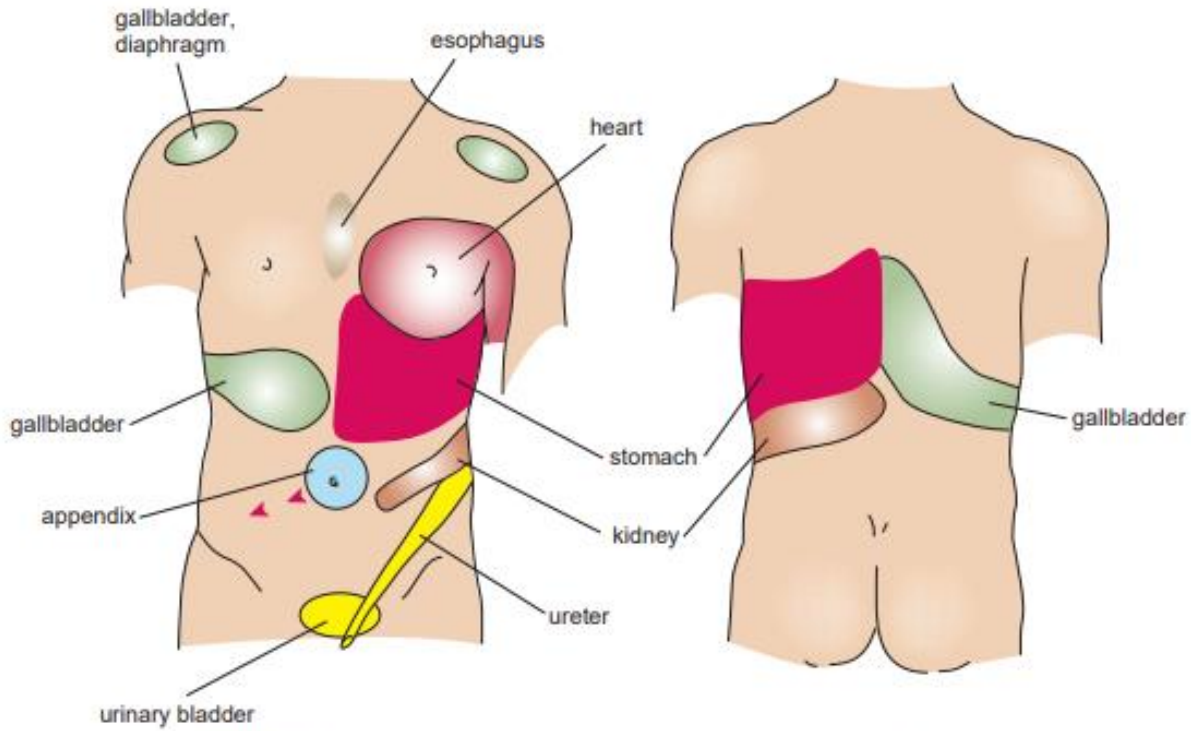


FIGURE 5.17 Some important skin areas involved in referred visceral pain.

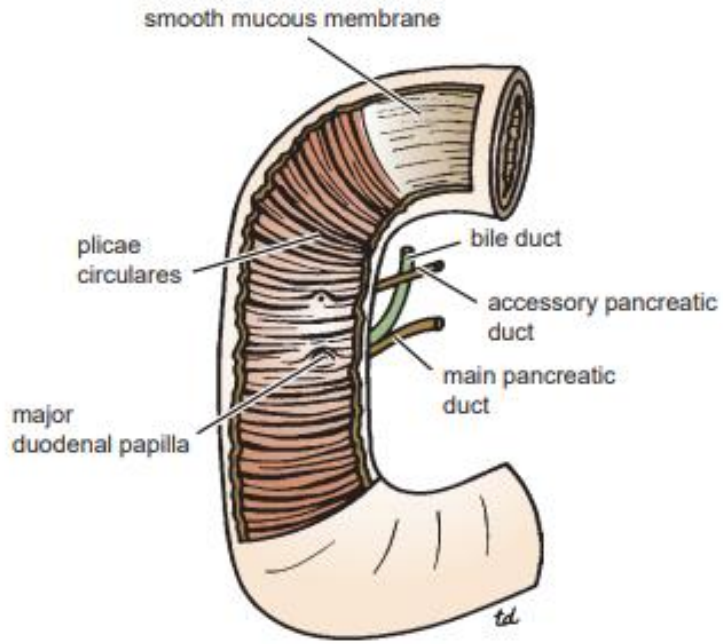


FIGURE 5.28 Entrance of the bile duct and the main and accessory pancreatic ducts into the second part of the duodenum. Note the smooth lining of the first part of the duodenum, the plicae circulares of the second part, and the major duodenal papilla.

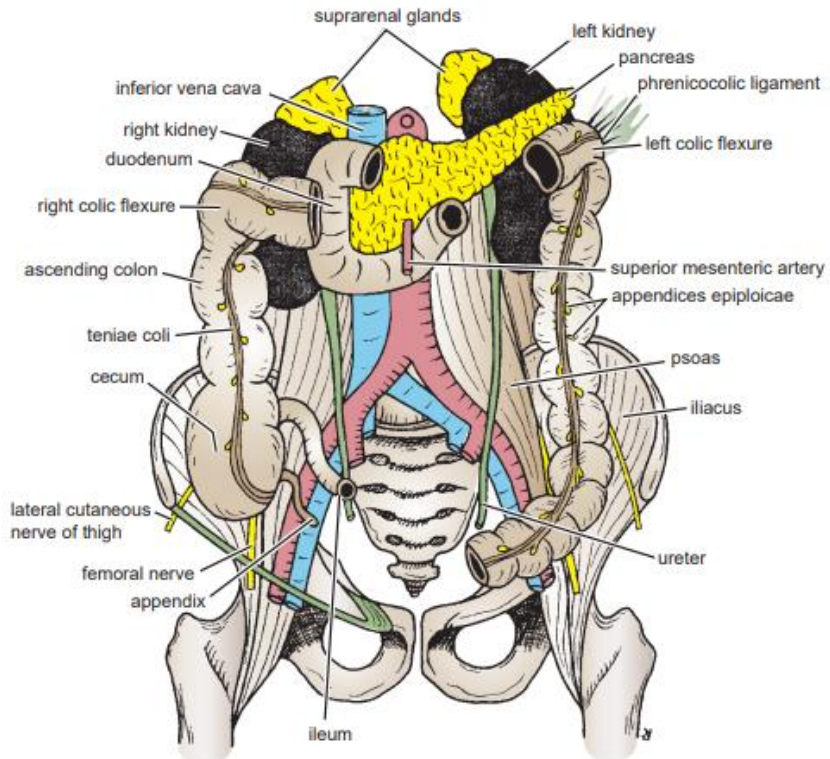


FIGURE 5.35 Abdominal cavity showing the terminal part of the ileum, the cecum, the appendix, the ascending colon, the right colic flexure, the left colic flexure, and the descending colon. Note the teniae coli and the appendices epiploicae.

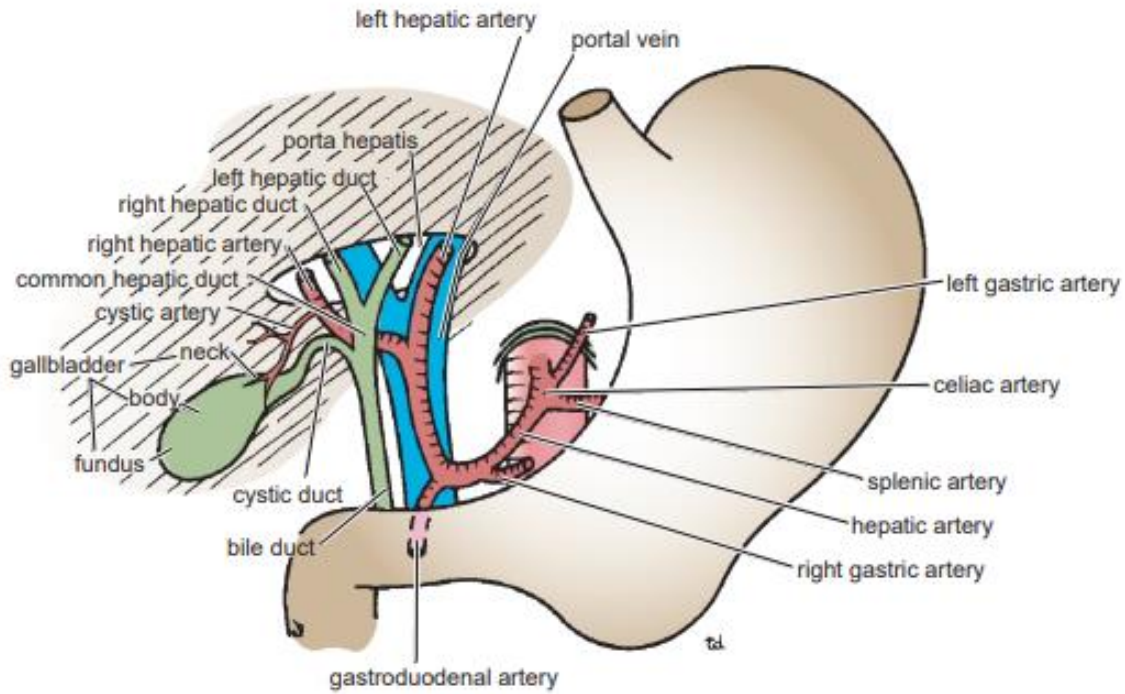
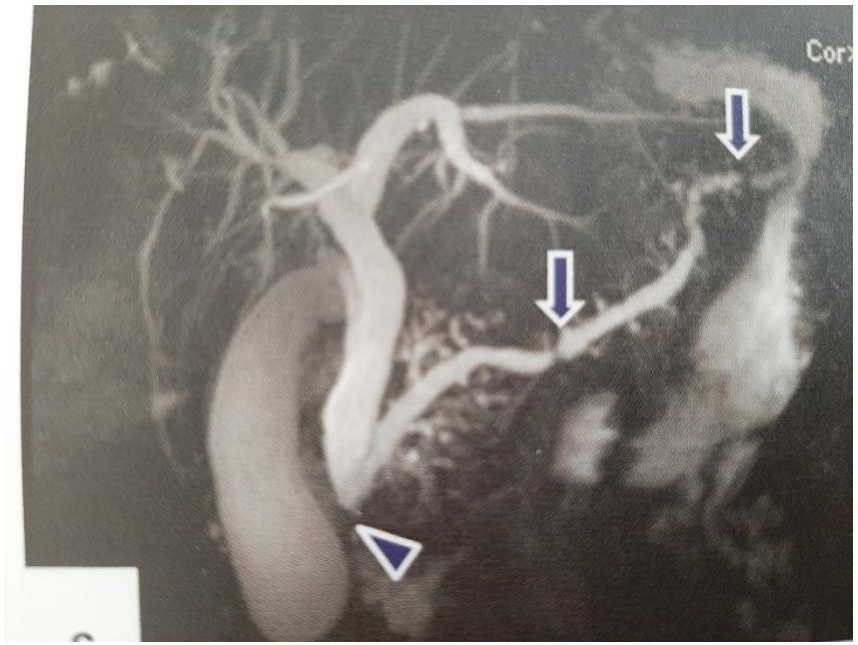
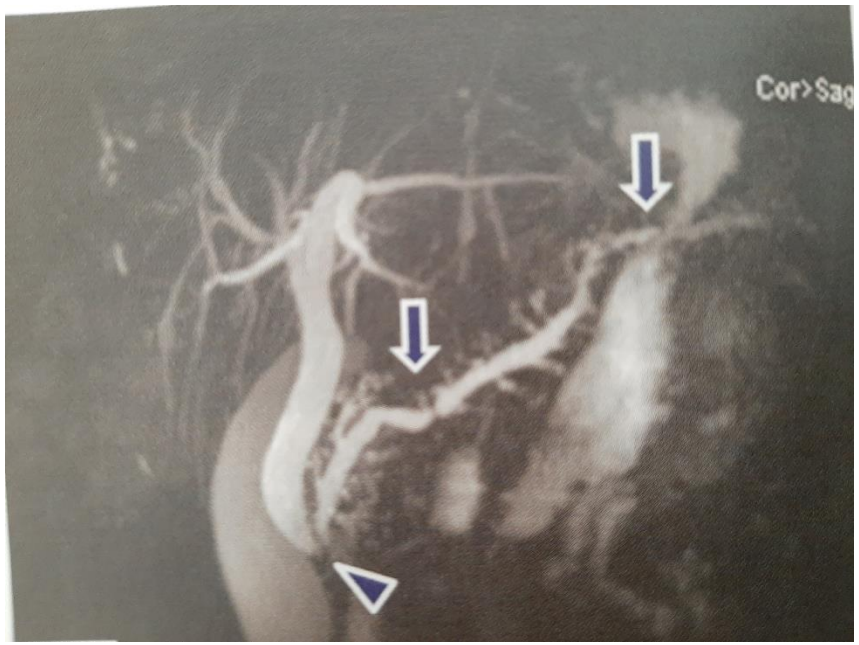
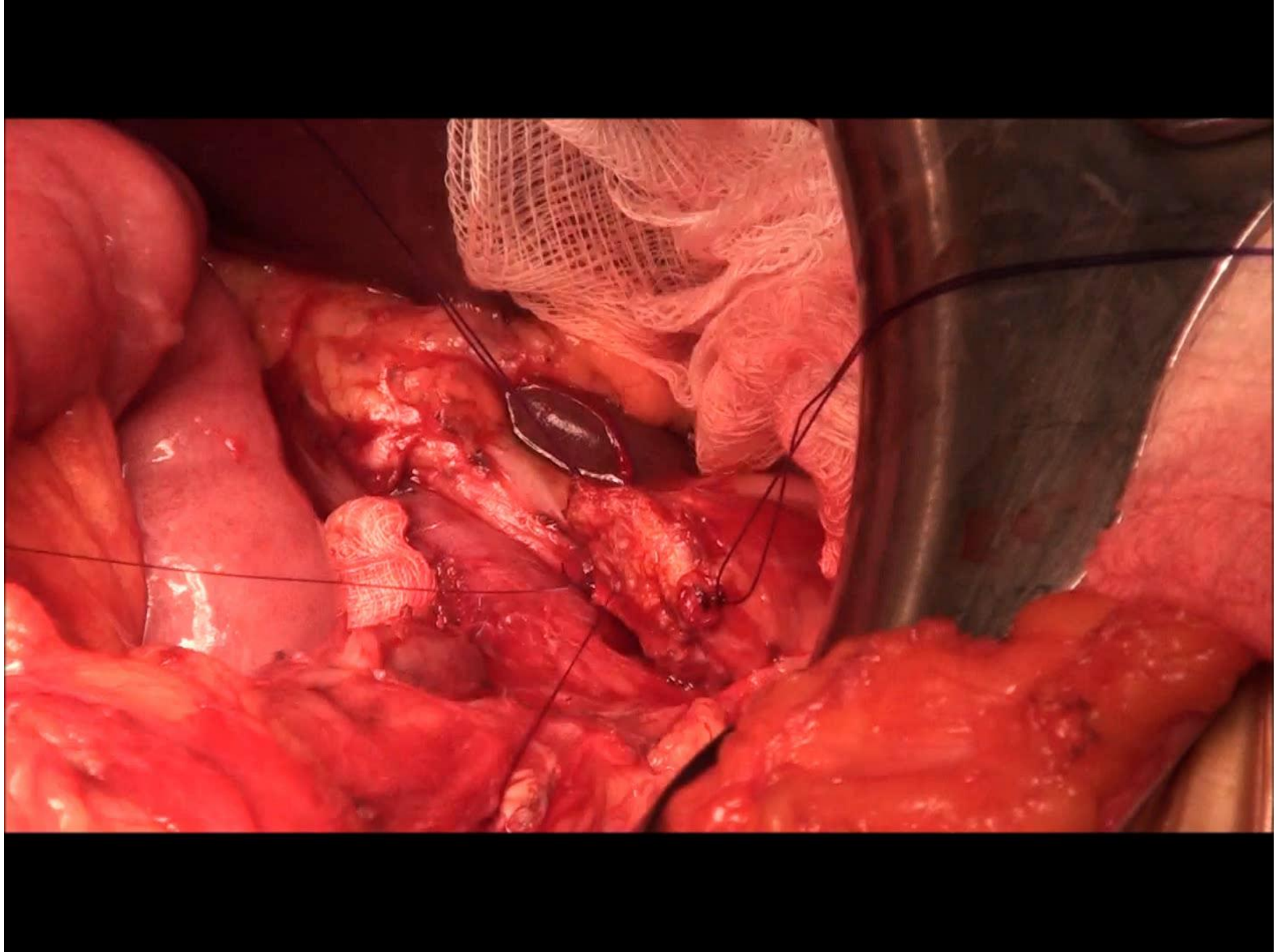


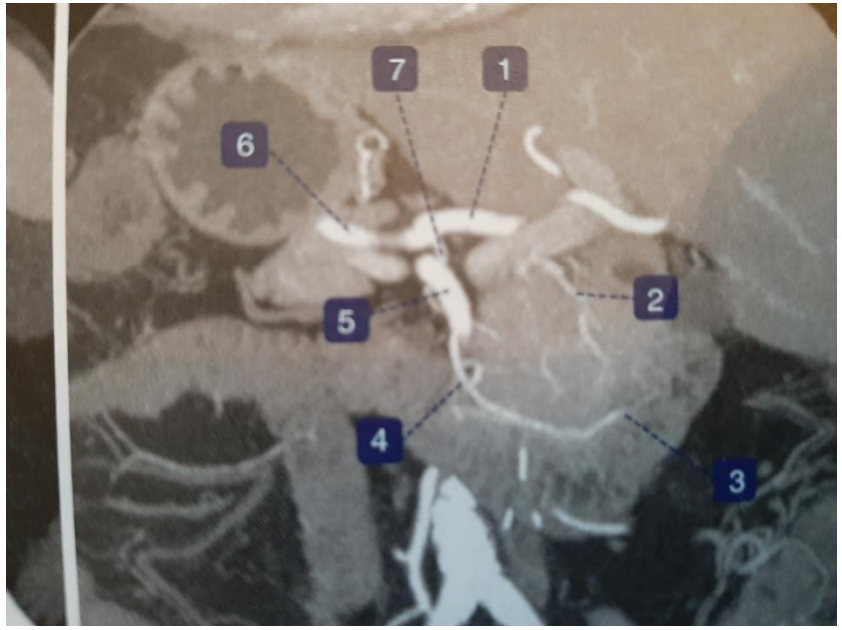
FIGURE 5.47 Structures entering and leaving the porta hepatis.

OPERATIVE AND RADIOLOGICAL ANATOMY





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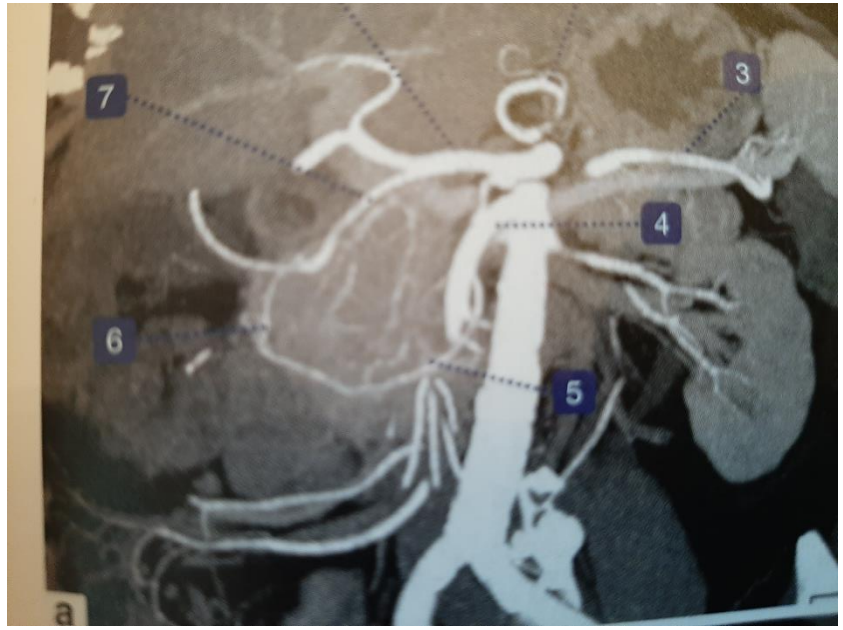
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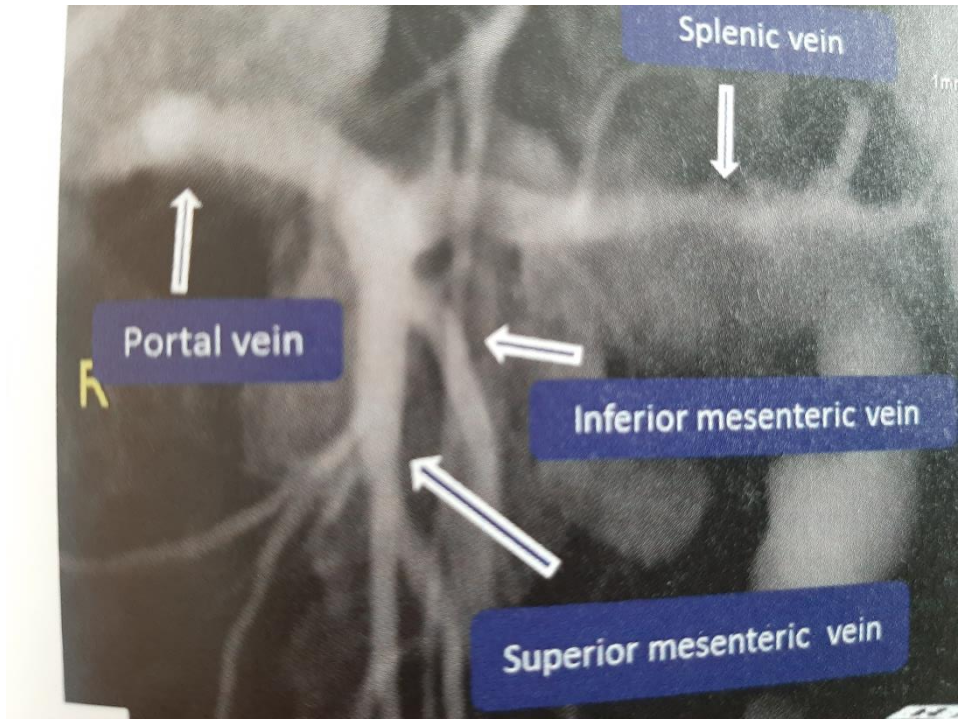
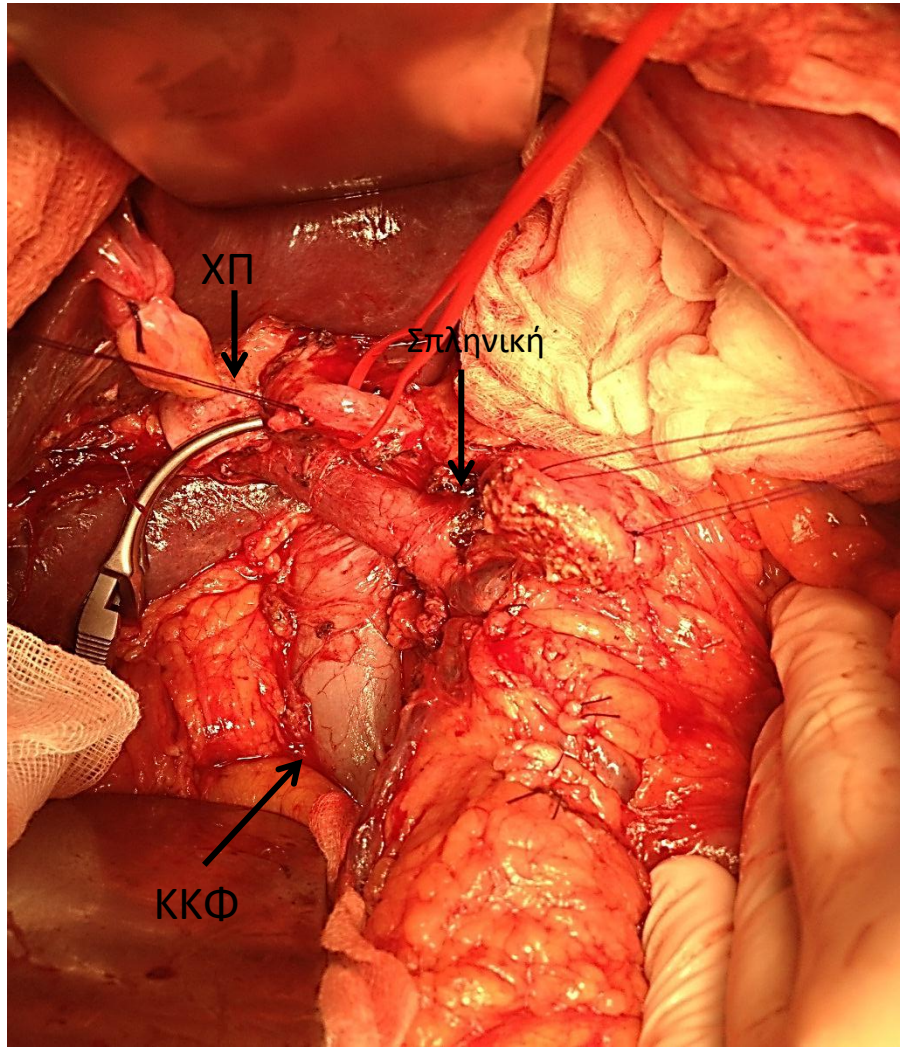
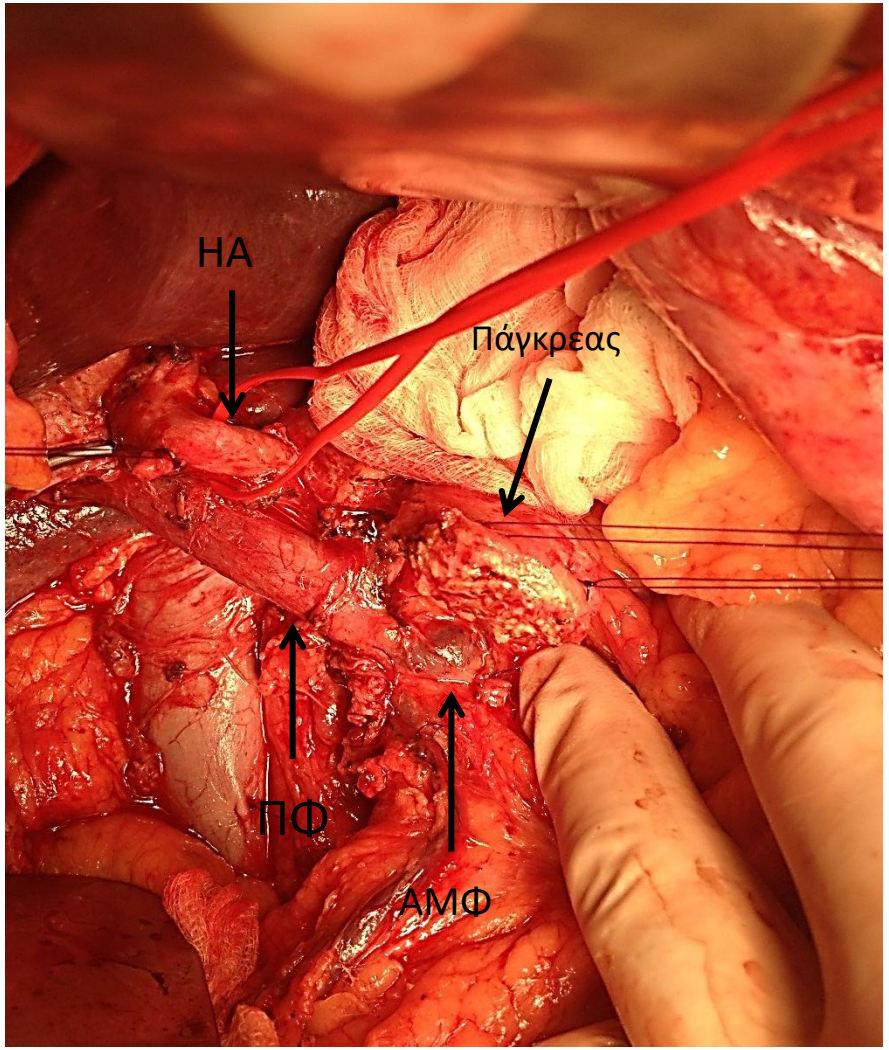
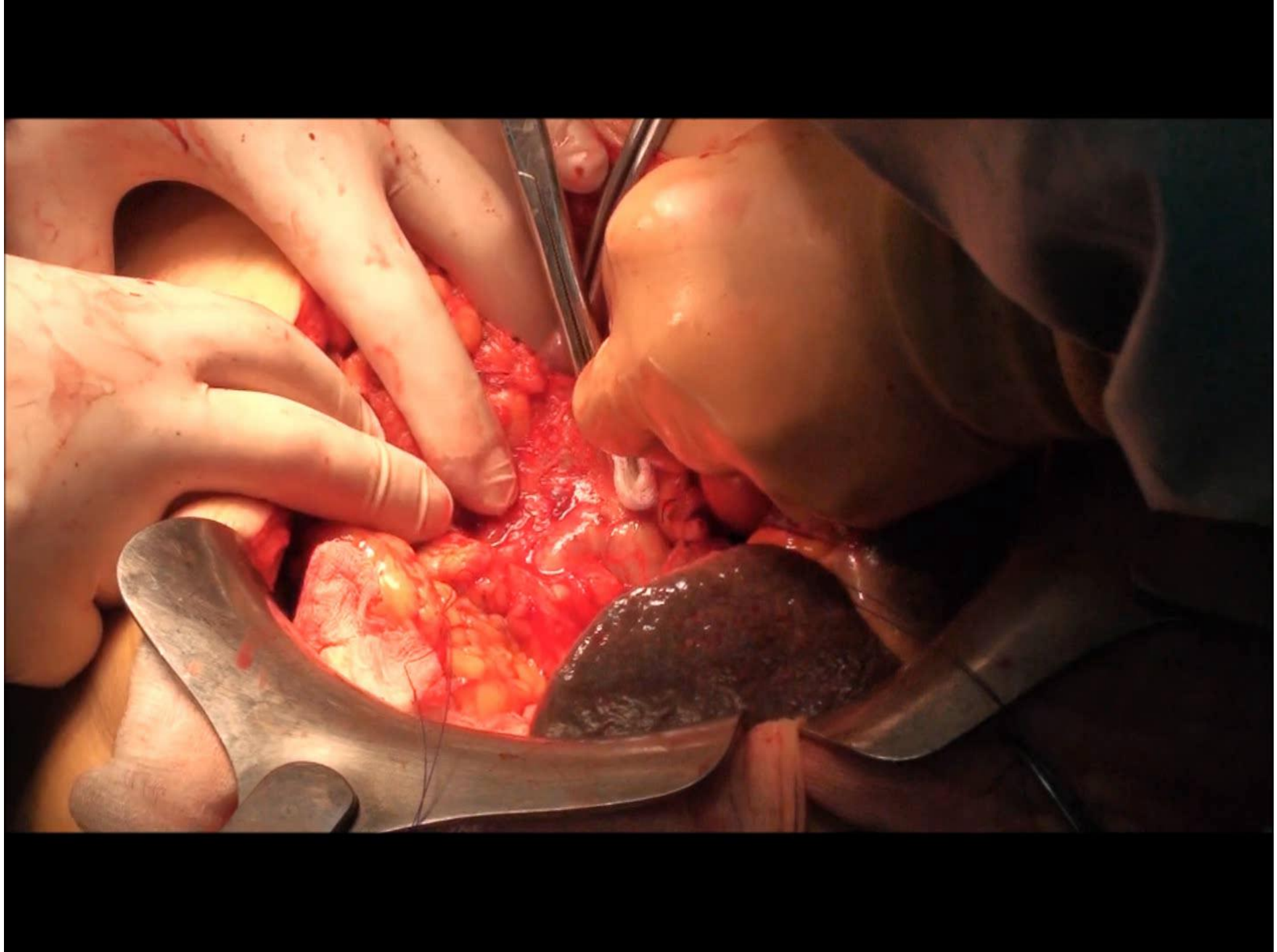

Splenic vein
Portal vein
Inferior mesenteric vein
Superior mesenteric vein

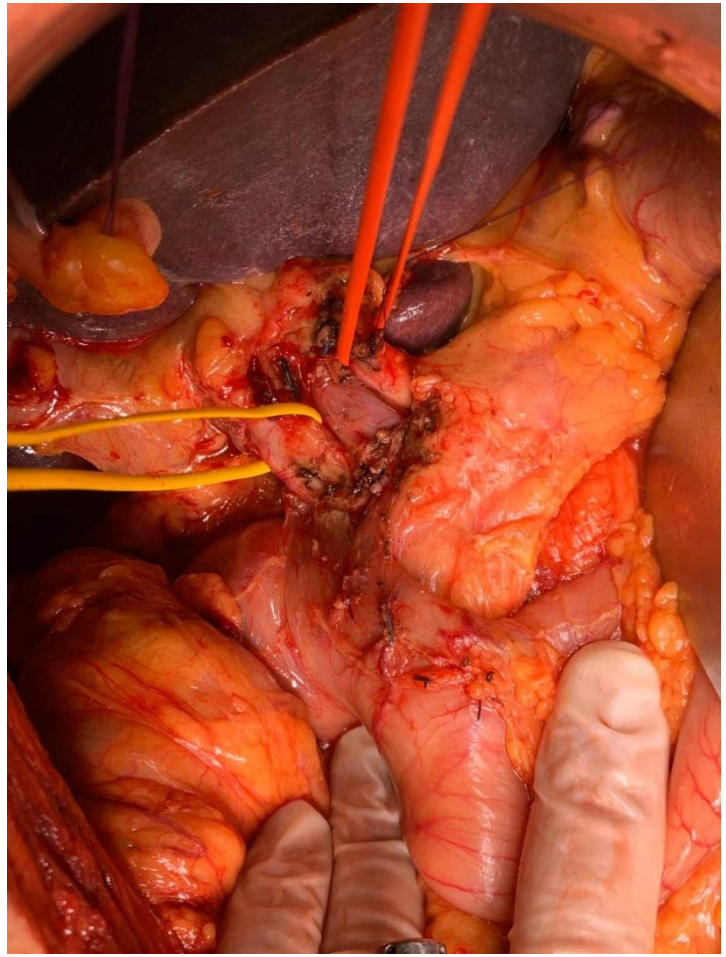

SA
SM

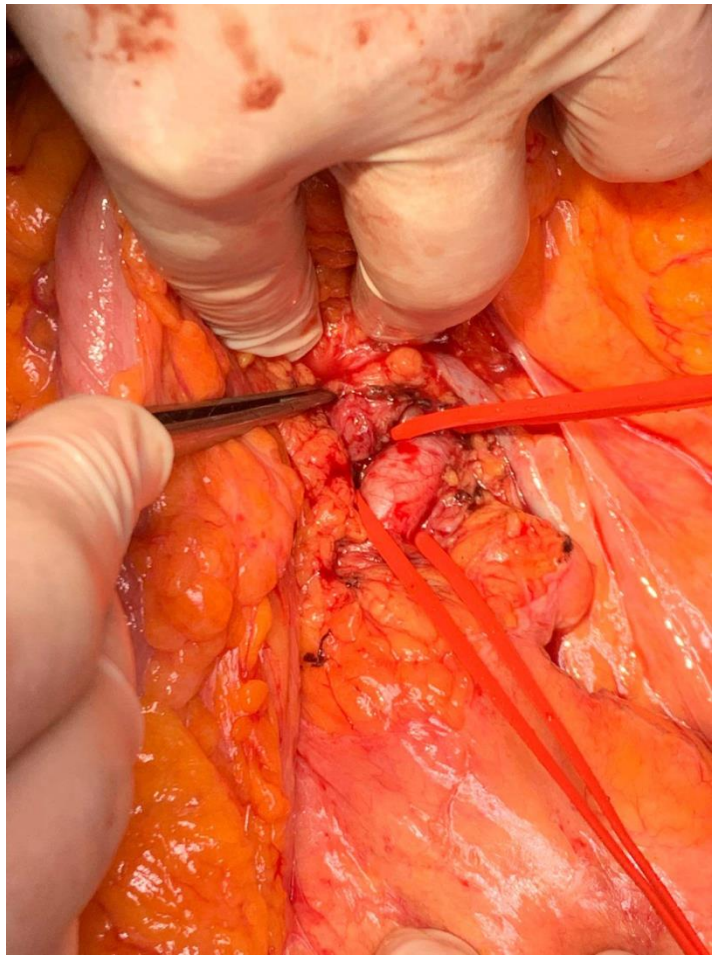
PORTAL VEIN

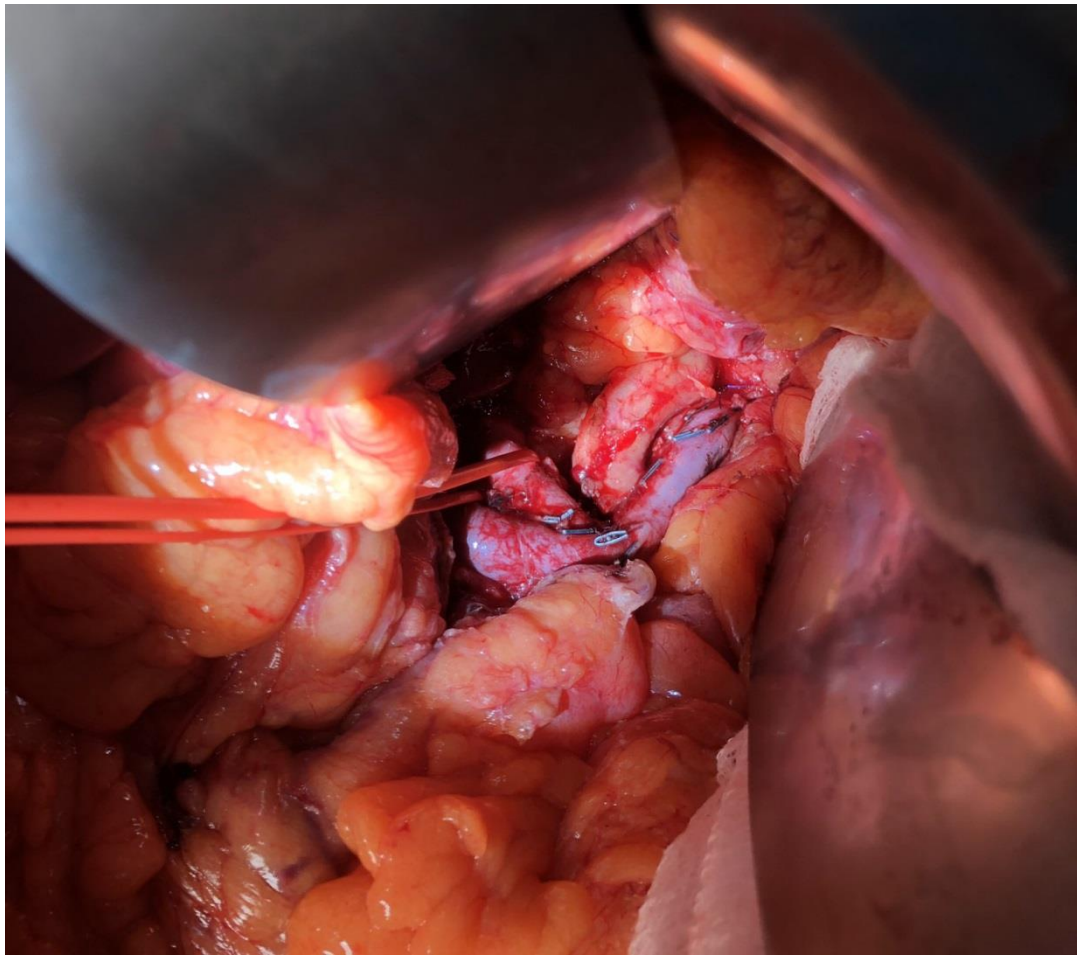


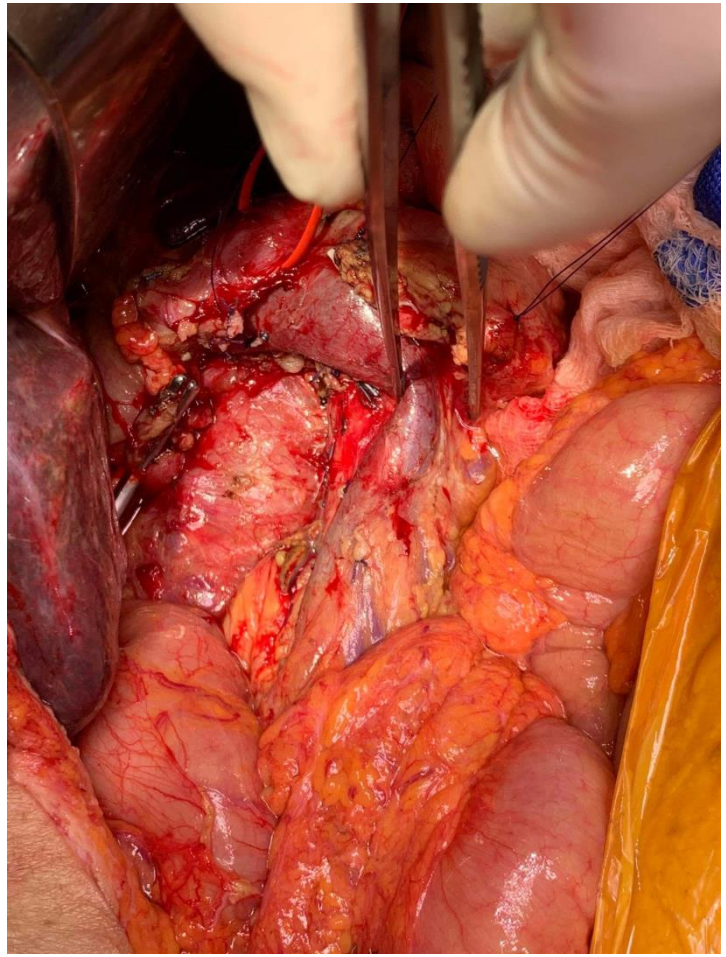


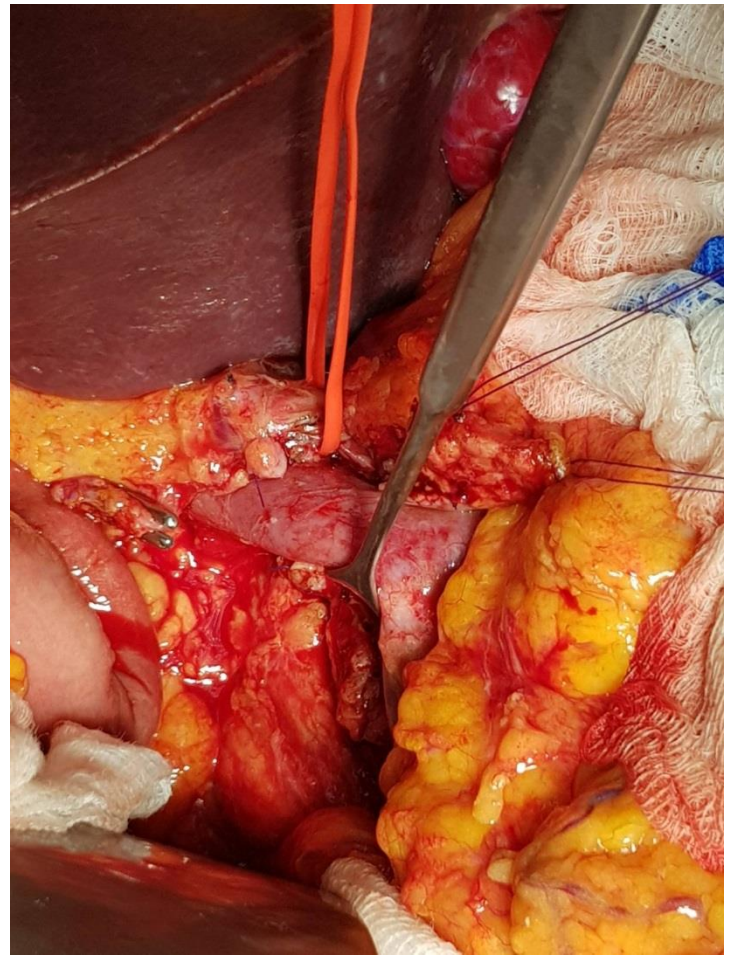


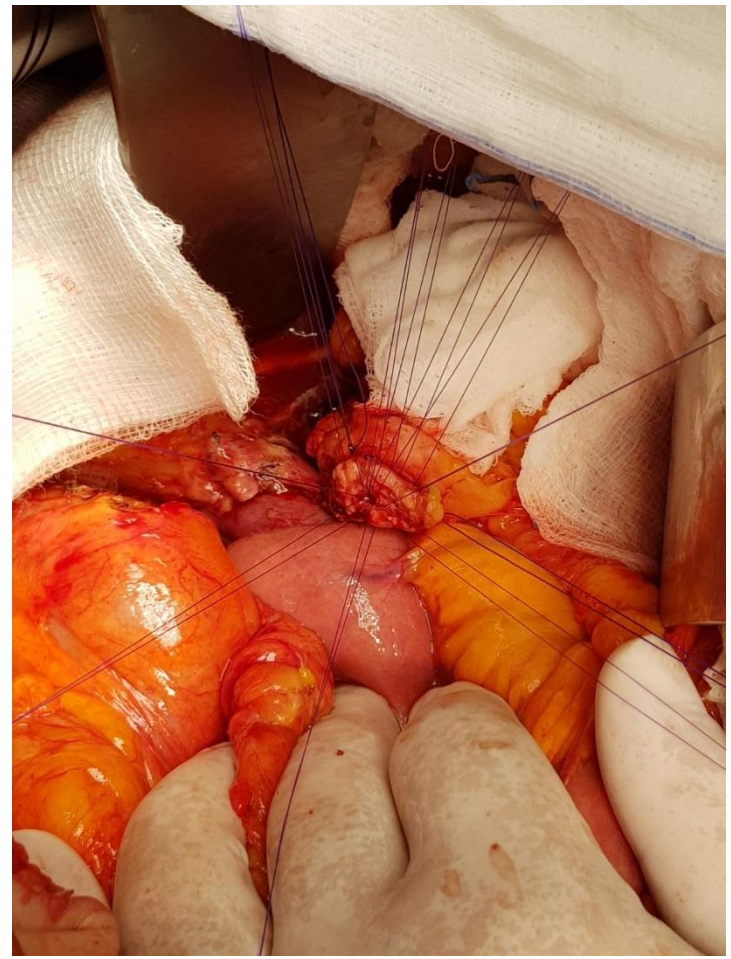


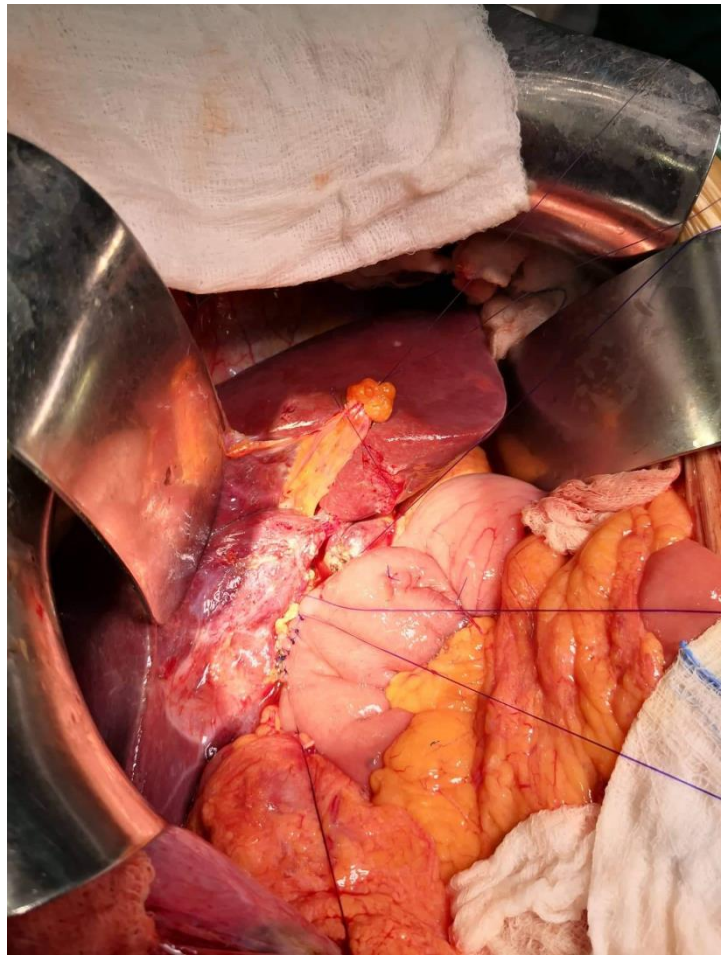


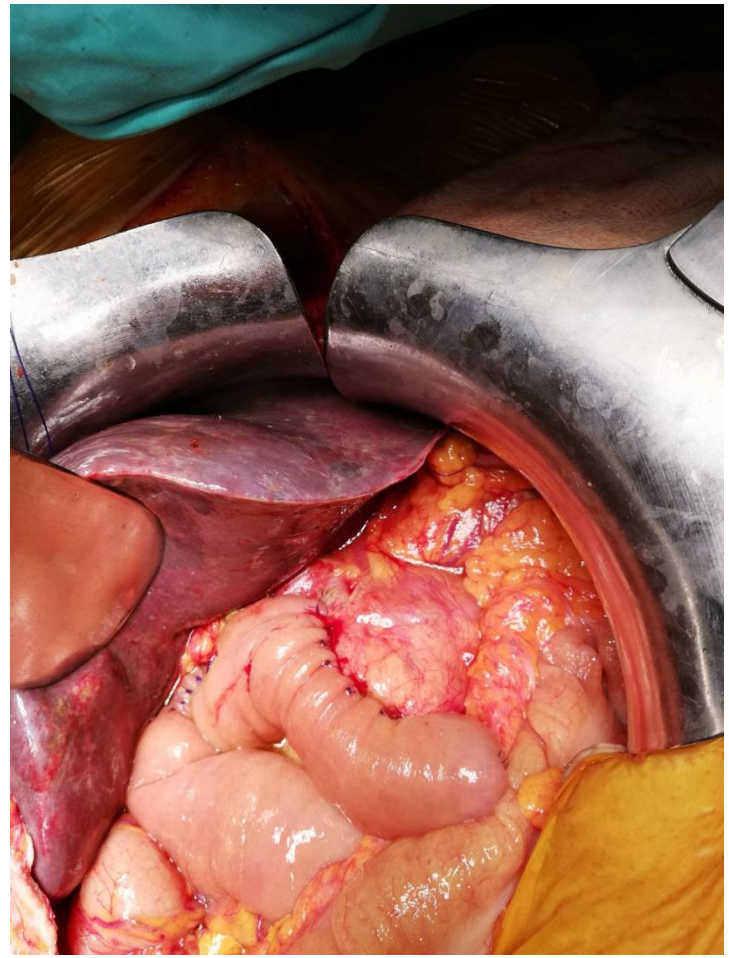


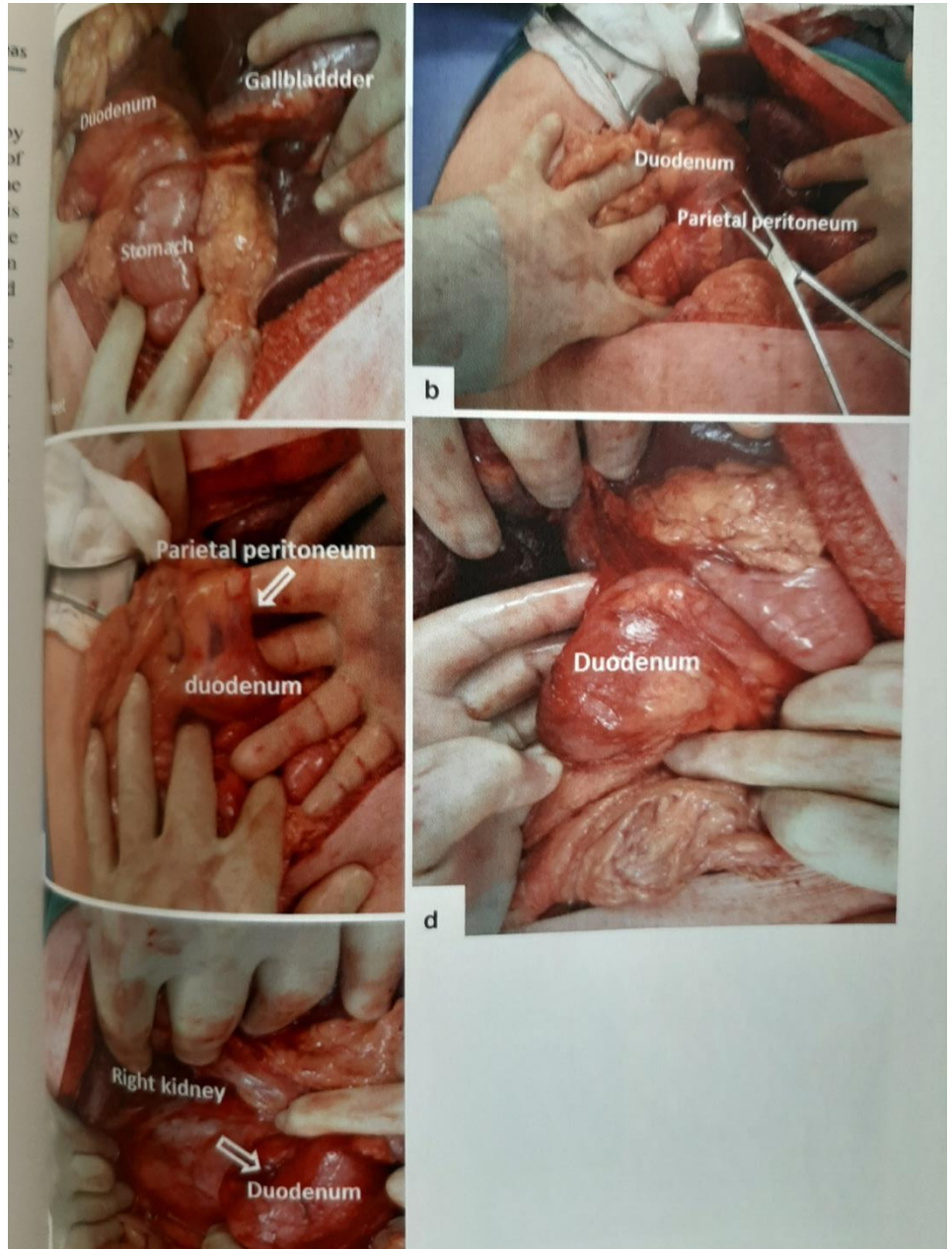











Duodenum
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Stomach
Parietal peritoneum
duodenum
Right kidney
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Duodenum
Parietal peritoneum
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Duodenum
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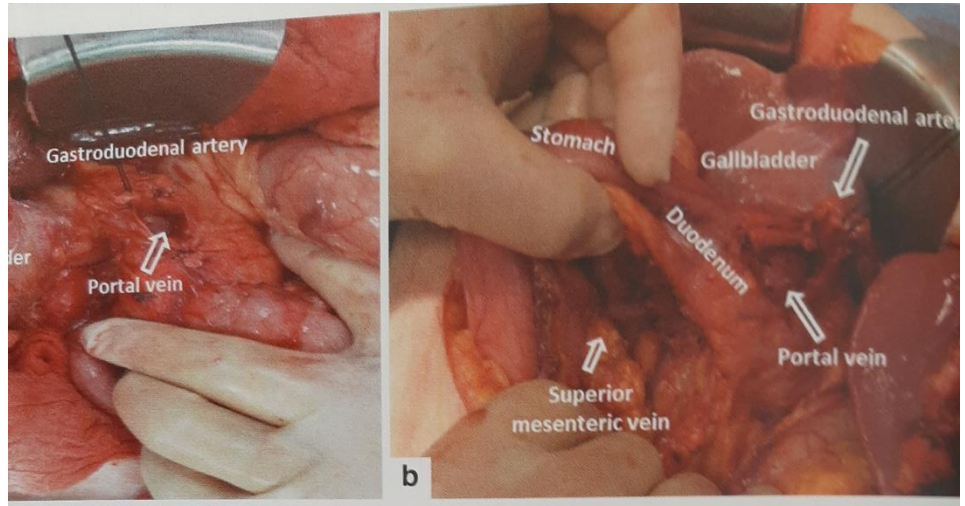
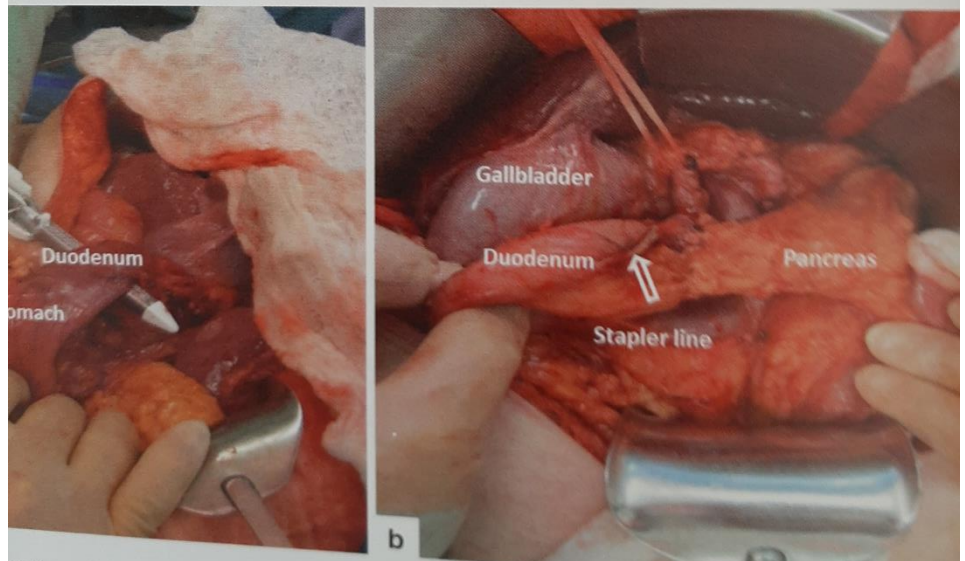
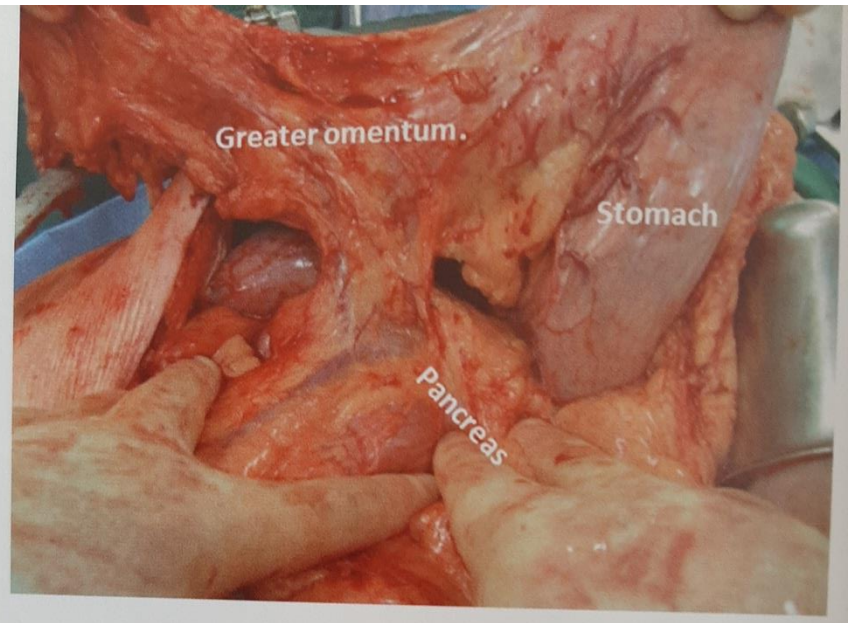
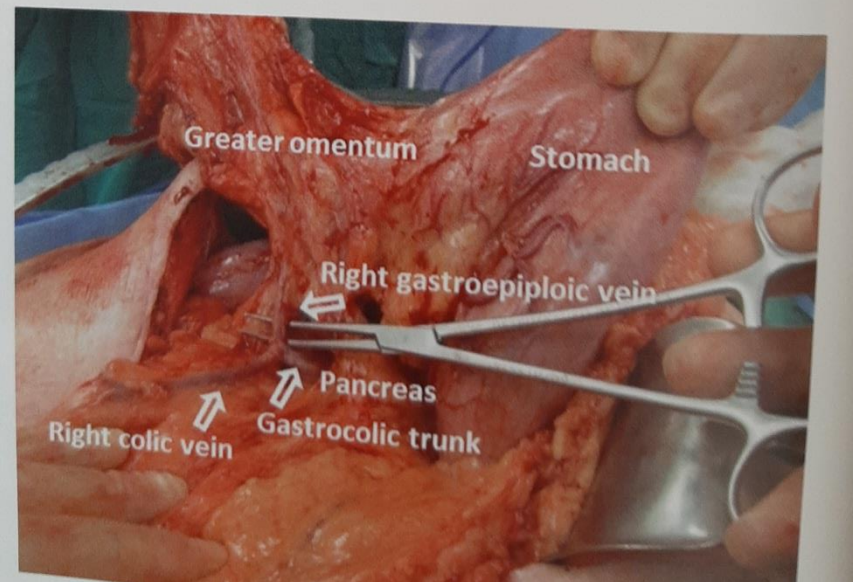


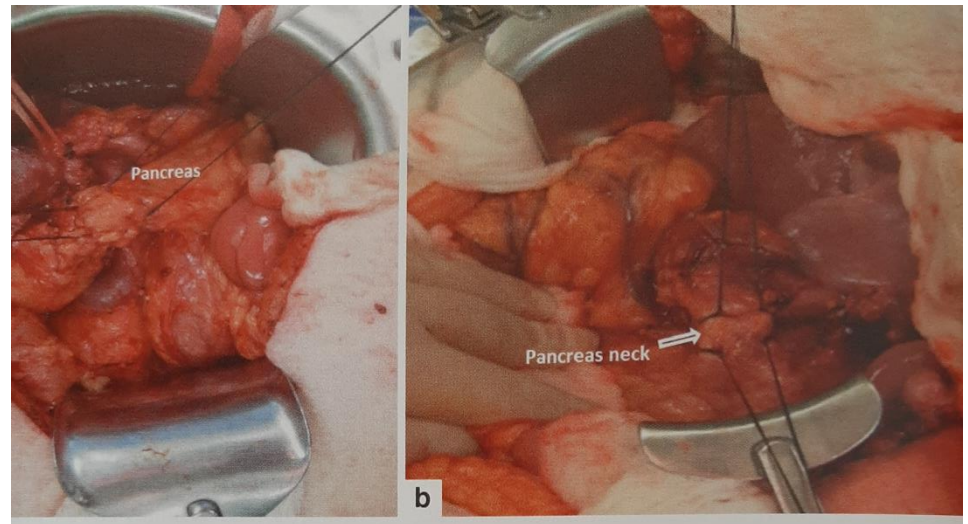
tion along the lesser curvature of the stomach (**a**, **b**)



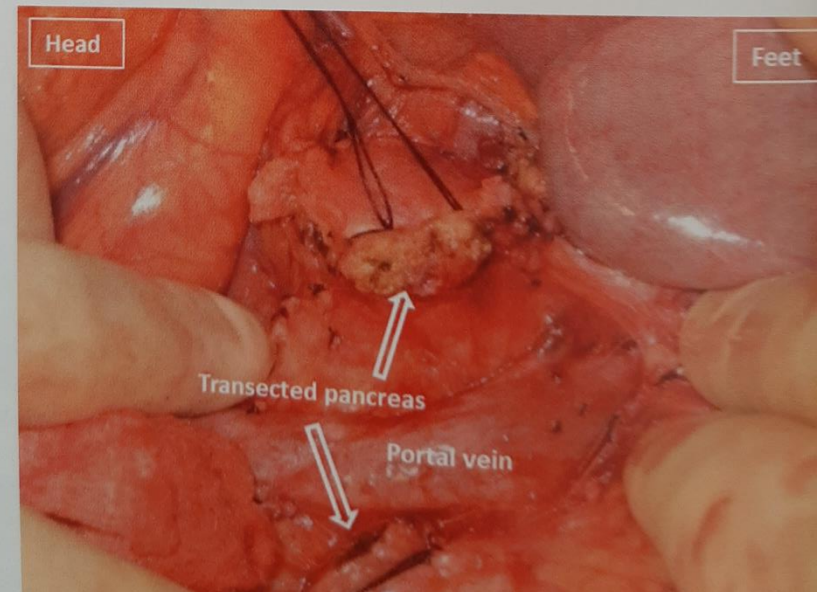
section of the duodenum (**a**, **b**)


Greater omentum.
Stomach
Pancreas

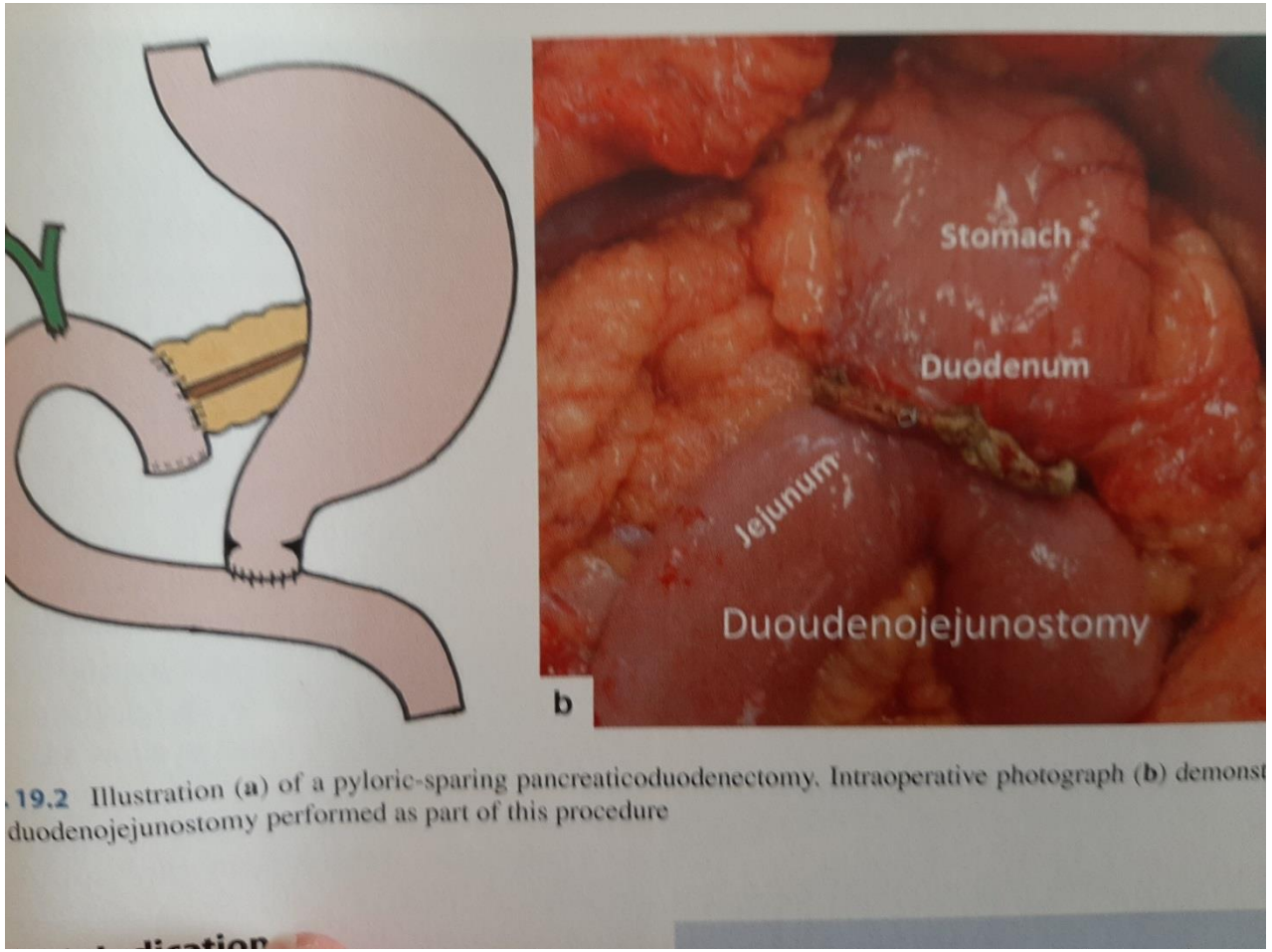

Greater omentum
Stomach
Right gastroepiploic vein
Pancreas
Gastrocolic trunk
Right colic vein



ansection of the pancreas (**a**, **b**)




pleted duodeno-jejunostomy
Jejunum
Jejunum
Duodenum
Stomach



19.2 Illustration (**a**) of a pyloric-sparing pancreaticoduodenectomy. Intraoperative photograph (**b**) demonst
duodenojejunostomy performed as part of this procedure

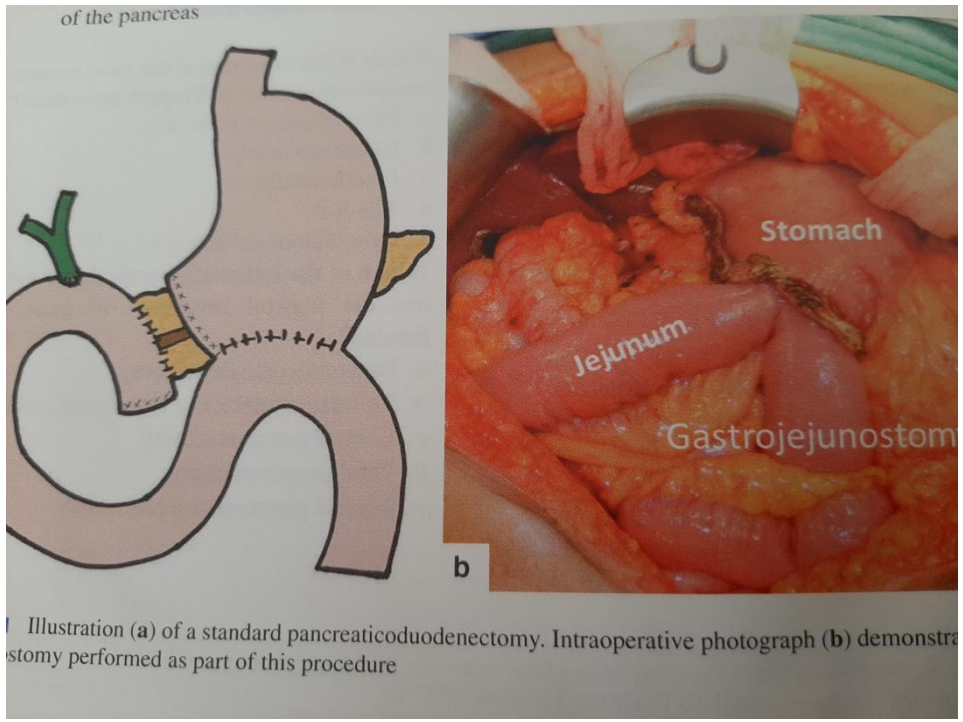
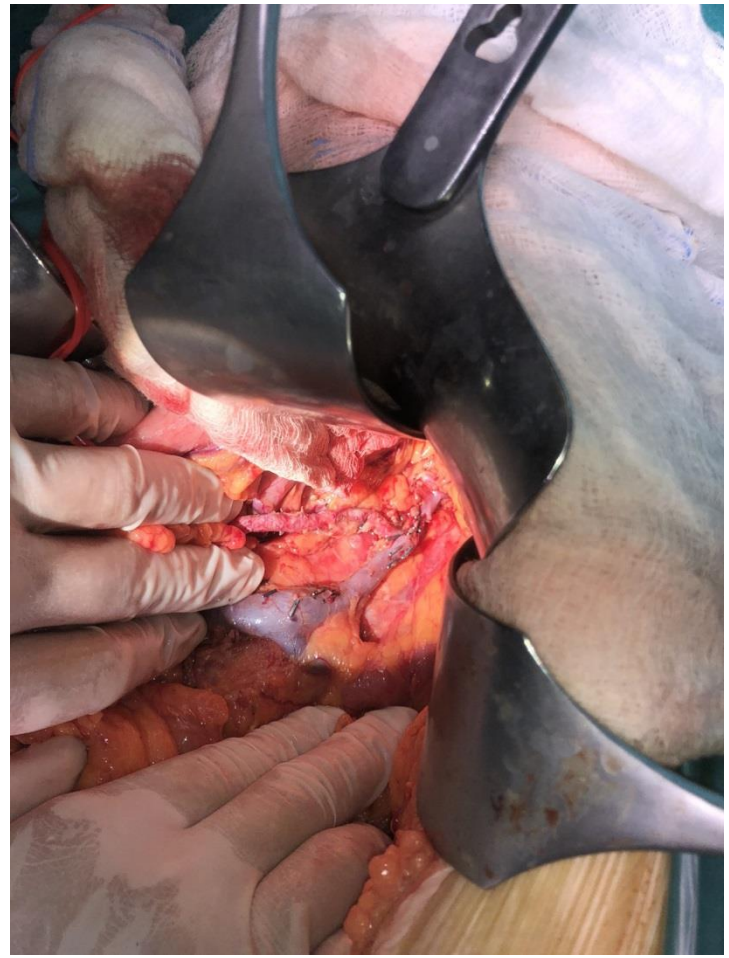


Illustration (**a**) of a standard pancreaticoduodenectomy. Intraoperative photograph (**b**) demonstra
stomy performed as part of this procedure



ANATOMY OF THE SPLEEN

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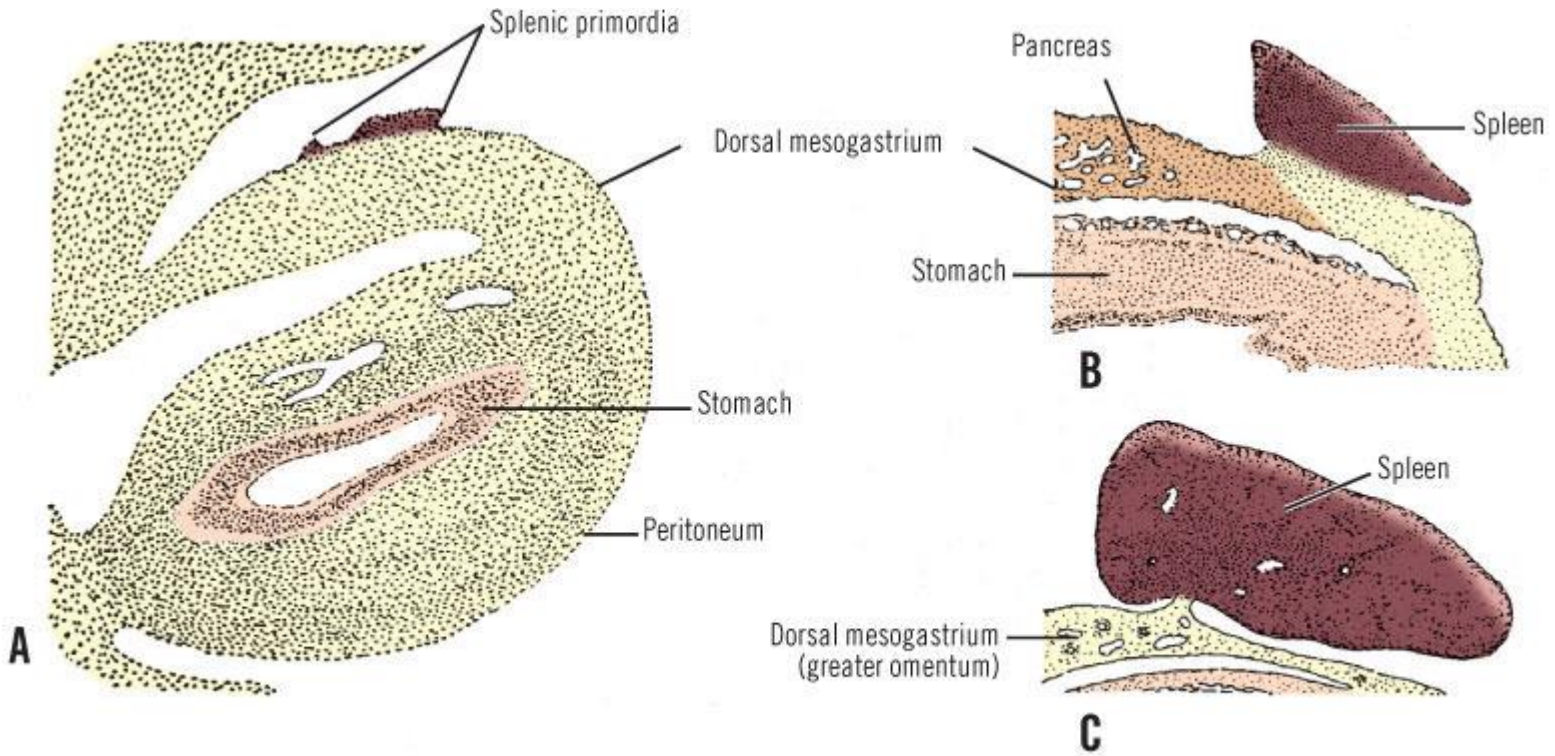
EMBRYOLOGY



LACATION AND DESCRIPTION

- Reddish, the largest single mass of lymphoid tissue in the body.
- It is oval shaped and has a notched anterior border.
- It lies just beneath the left half of the diaphragm close to the 9th, 10th, and 11th ribs.
- The long axis lies along the shaft of the 10th rib, and its lower pole extends forward only as far as the midaxillary line and cannot be palpated on clinical examination .
- The spleen is surrounded by peritoneum, which passes from it at the hilum as the gastrosplenic omentum (ligament) to the greater curvature of the stomach (carrying the short gastric and left gastroepiploic vessels).

The peritoneum also passes to the left kidney as the splenicorenal ligament (carrying the splenic vessels and the tail of the pancreas)

- The spleen can be very small or very large. The extremes are 1 ounce and 20 pounds, as reported by Gould and Pyle.30 Spleens of extreme size may be healthy or diseased.

- The size of the spleen can change readily, enlarging with increases in blood pressure. The size increases after meals; conversely, its size decreases during exercise or immediately postmortem. The lymphoid tissue of the spleen, like lymphoid tissue elsewhere in the body, undergoes diminution sometime after the patient reaches the age of 10 years.31 There is some involution of the organ as a whole after the age of 60 years.

- Under normal conditions, the long axis of the organ runs parallel to the tenth rib. With splenomegaly, the spleen is palpable below the left costal margin, with its long axis extending down and forward along the tenth rib.32,33

- The spleen measures 1 x 3 x 5 inches (2.5 x 7.5 x 12.5 cm)

- The spleen weighs 7 oz (220 g)

- The spleen relates to left ribs 9 through 11
-

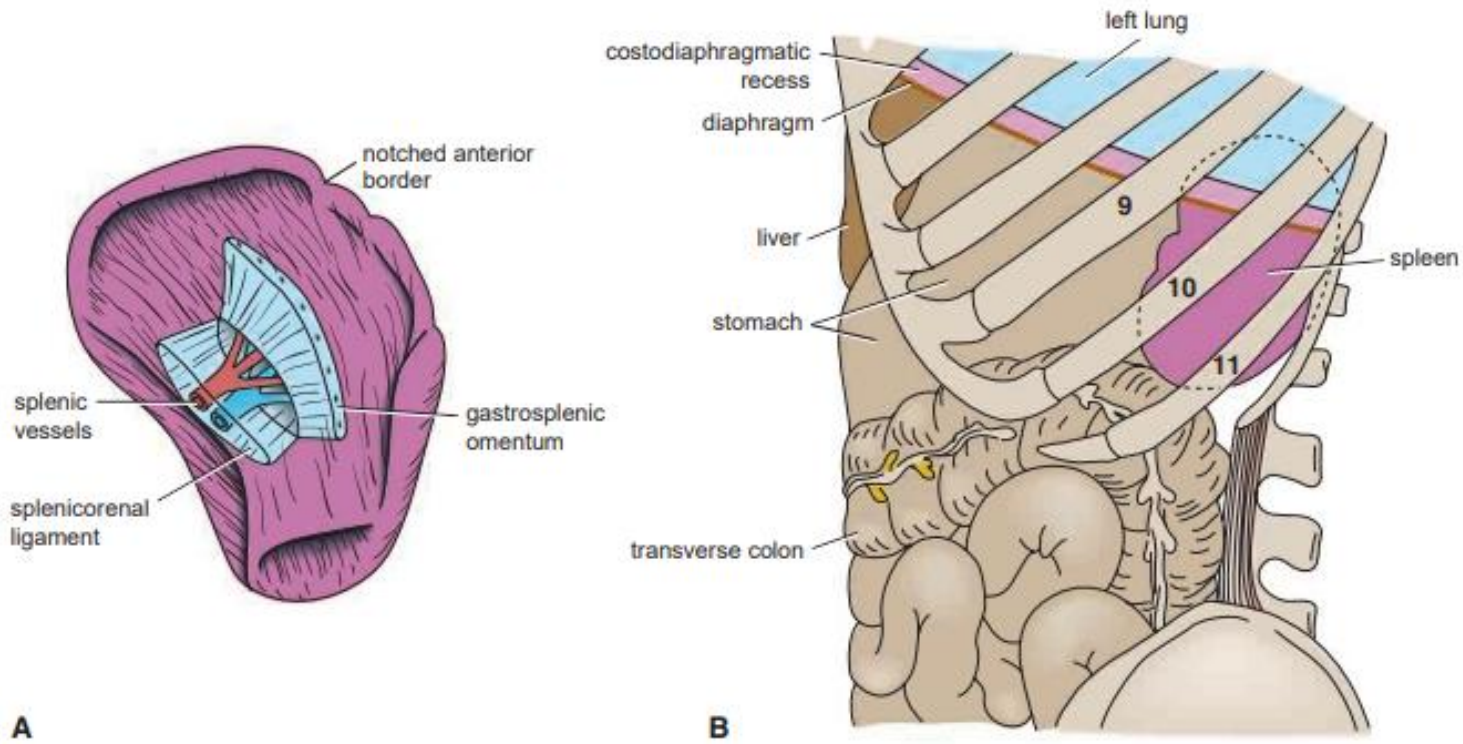
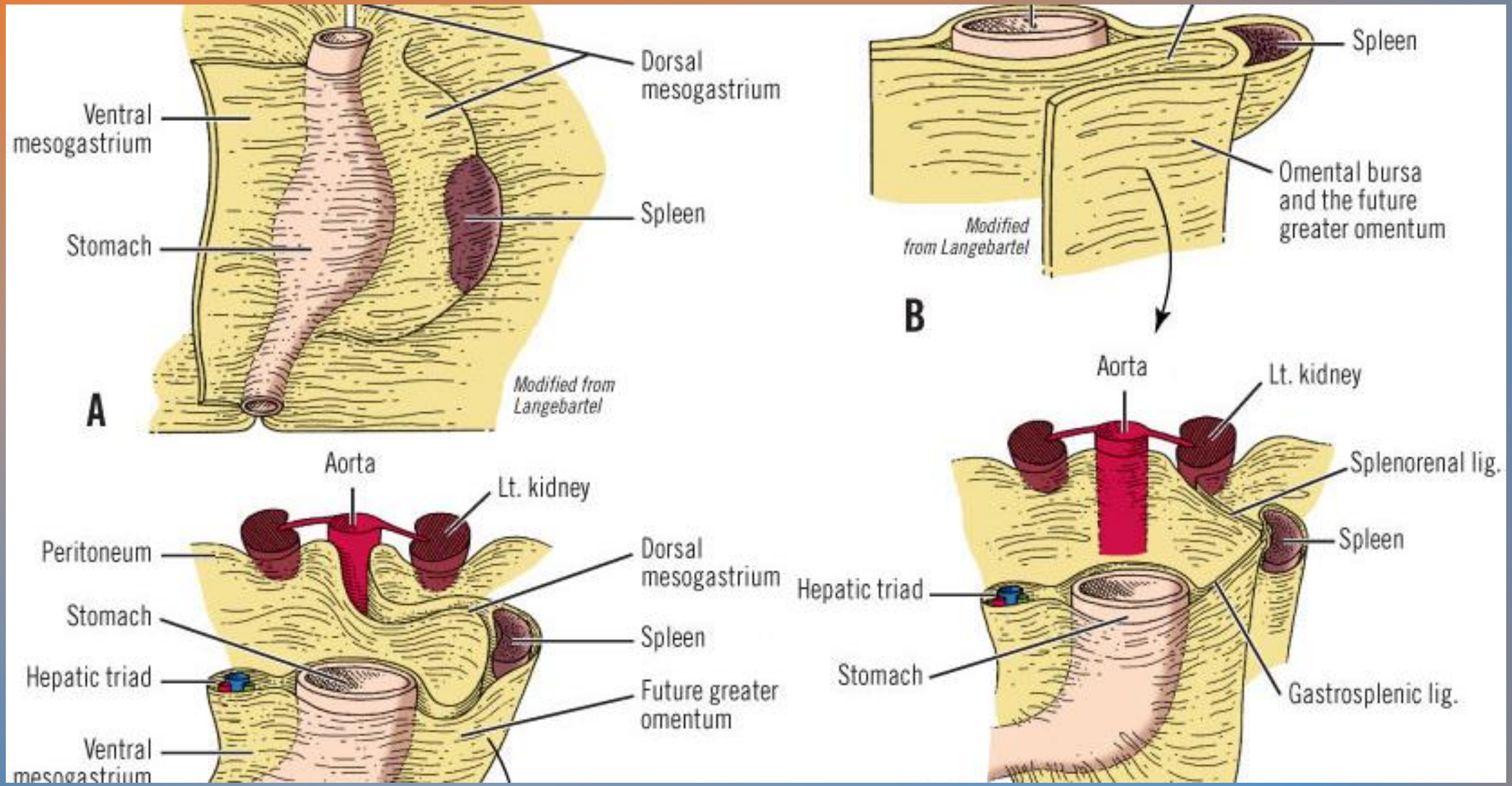


FIGURE 5.61 Spleen. **A.** It is oval shaped and has a notched anterior border. **B.** Shows relation of spleen to adjacent structures.

RELATIONS

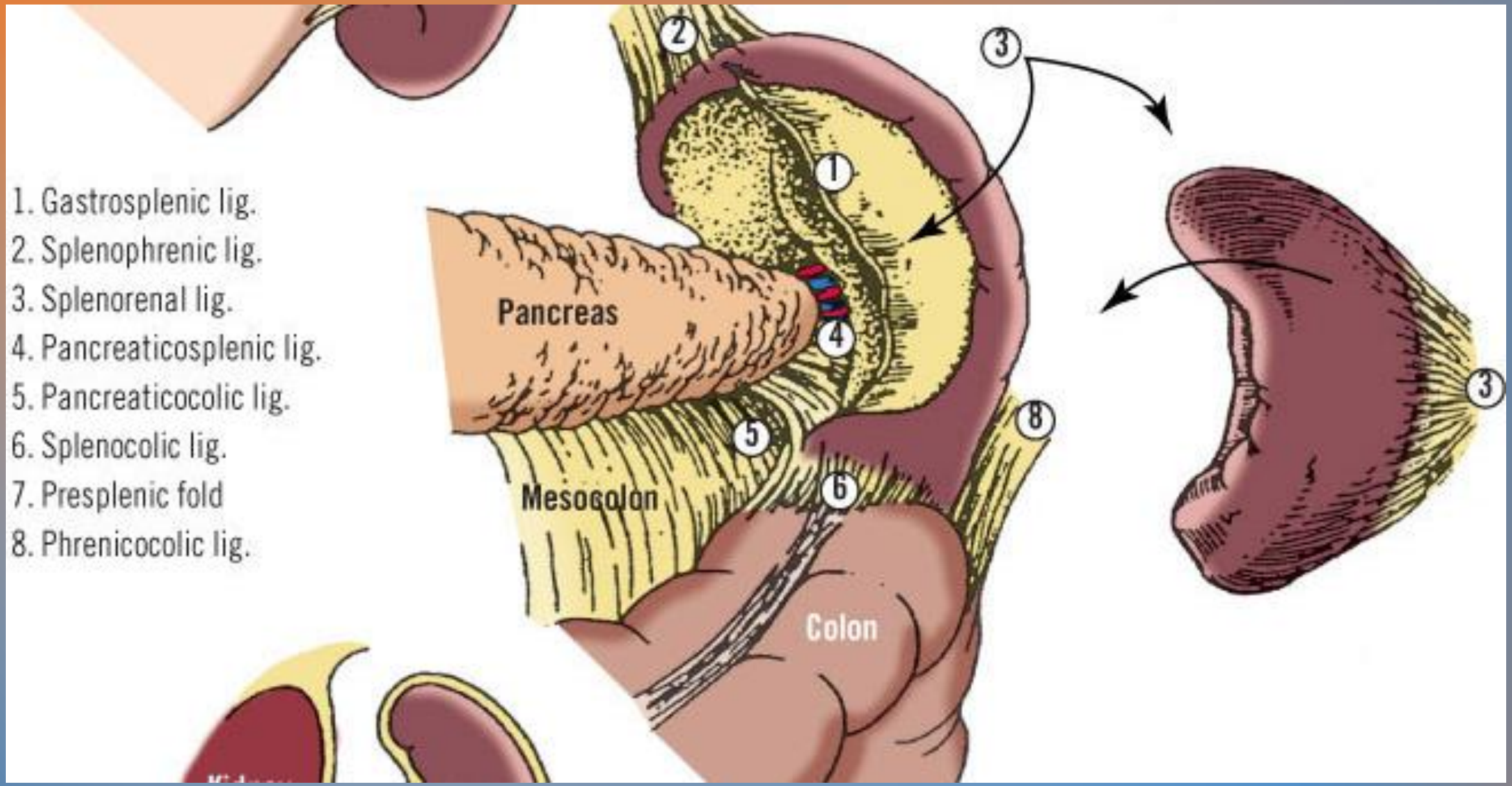
■ Anteriorly: The stomach, tail of the pancreas, and left colic flexure. The left kidney lies along its medial border.

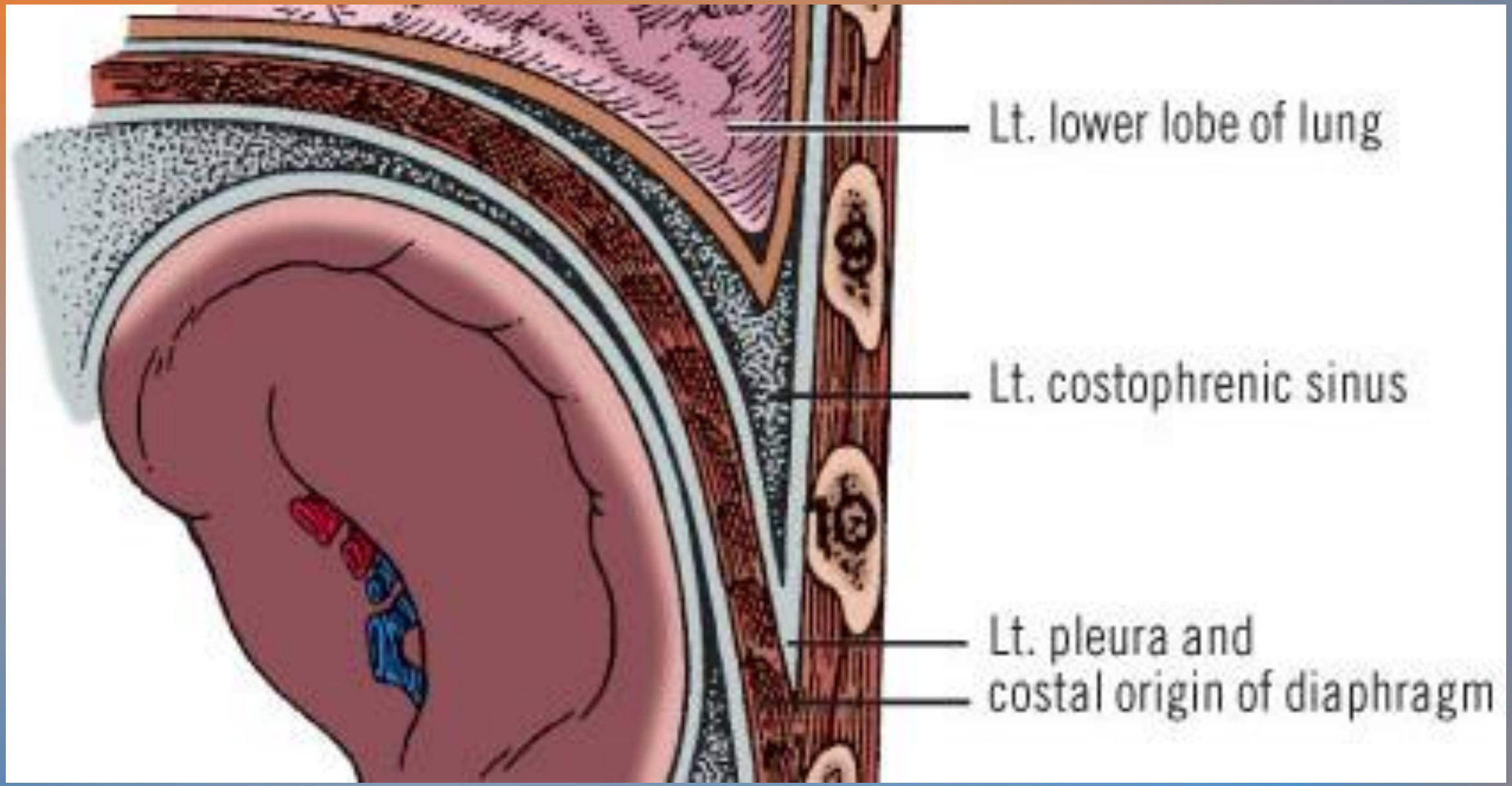
■ Posteriorly: The diaphragm; left pleura (left costodiaphragmatic recess); left lung; and 9th, 10th, and 11th ribs.


Dorsal mesogastrium
Ventral mesogastrium
Spleen
Stomach
Modified from Langebartel
A
Spleen
Omental bursa and the future greater omentum
Modified from Langebartel
B
Aorta
Lt. kidney
Peritoneum
Dorsal mesogastrium
Stomach
Spleen
Hepatic triad
Future greater omentum
Ventral mesogastrium
Aorta
Lt. kidney
Splenorenal lig.
Spleen
Hepatic triad
Stomach
Gastrosplenic lig.

SPLEEN LIGAMENTS

- Six ligaments (gastrosplenic, splenorenal, splenophrenic, splenocolic, and pancreatosplenic ligaments, and presplenic fold) are directly associated with the spleen. Two others (pancreaticocolic and phrenicocolic) are indirectly associated with the spleen. Most of the literature holds the gastrosplenic, splenorenal, and phrenicocolic ligaments responsible for ptosis of the spleen. Allen et al.2 suggested that from an anatomic standpoint, the other ligaments (especially the splenocolic ligament) also participate in the development of ptosis of the spleen


1. Gastrosplenic lig.
2. Splenophrenic lig.
3. Splenorenal lig.
4. Pancreaticosplenic lig.
5. Pancreaticocolic lig.
6. Splenocolic lig.
7. Presplenic fold
8. Phrenicocolic lig.
Pancreas
Mesocolon
Colon
1
2
3
4
5
6
8
3


Lt. lower lobe of lung
Lt. costophrenic sinus
Lt. pleura and
costal origin of diaphragm

BLOOD SUPPLY,NERVE SUPPLY

- Arteries.

The large splenic artery is the largest branch of the celiac artery.

It has a tortuous course as it runs along the upper border of the pancreas. The splenic artery then divides into about six branches, which enter the spleen at the hilum.

- Veins.

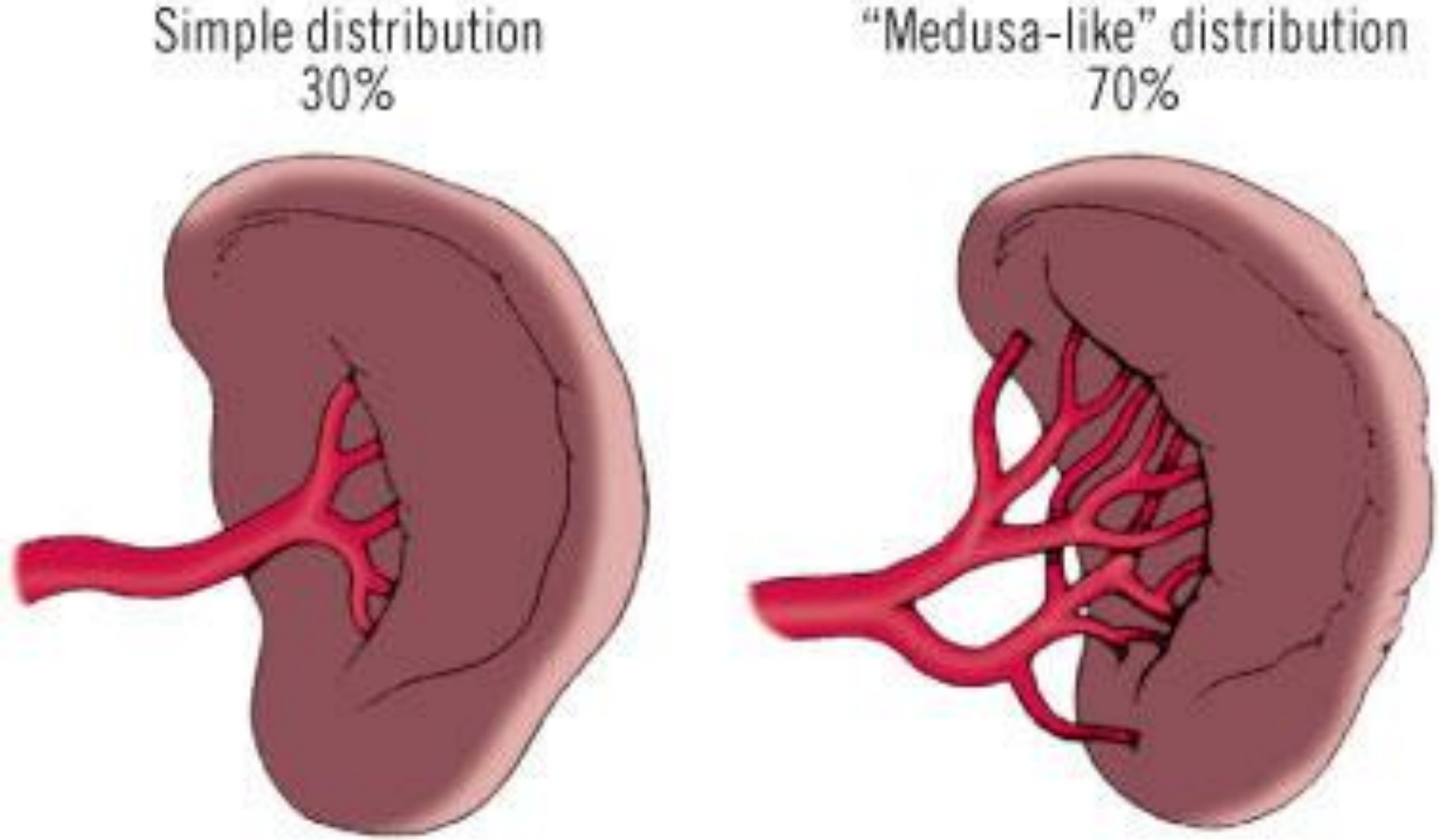
The splenic vein leaves the hilum and runs behind the tail and the body of the pancreas. Behind the neck of the pancreas, the splenic vein joins the superior mesenteric vein to form the portal vein.

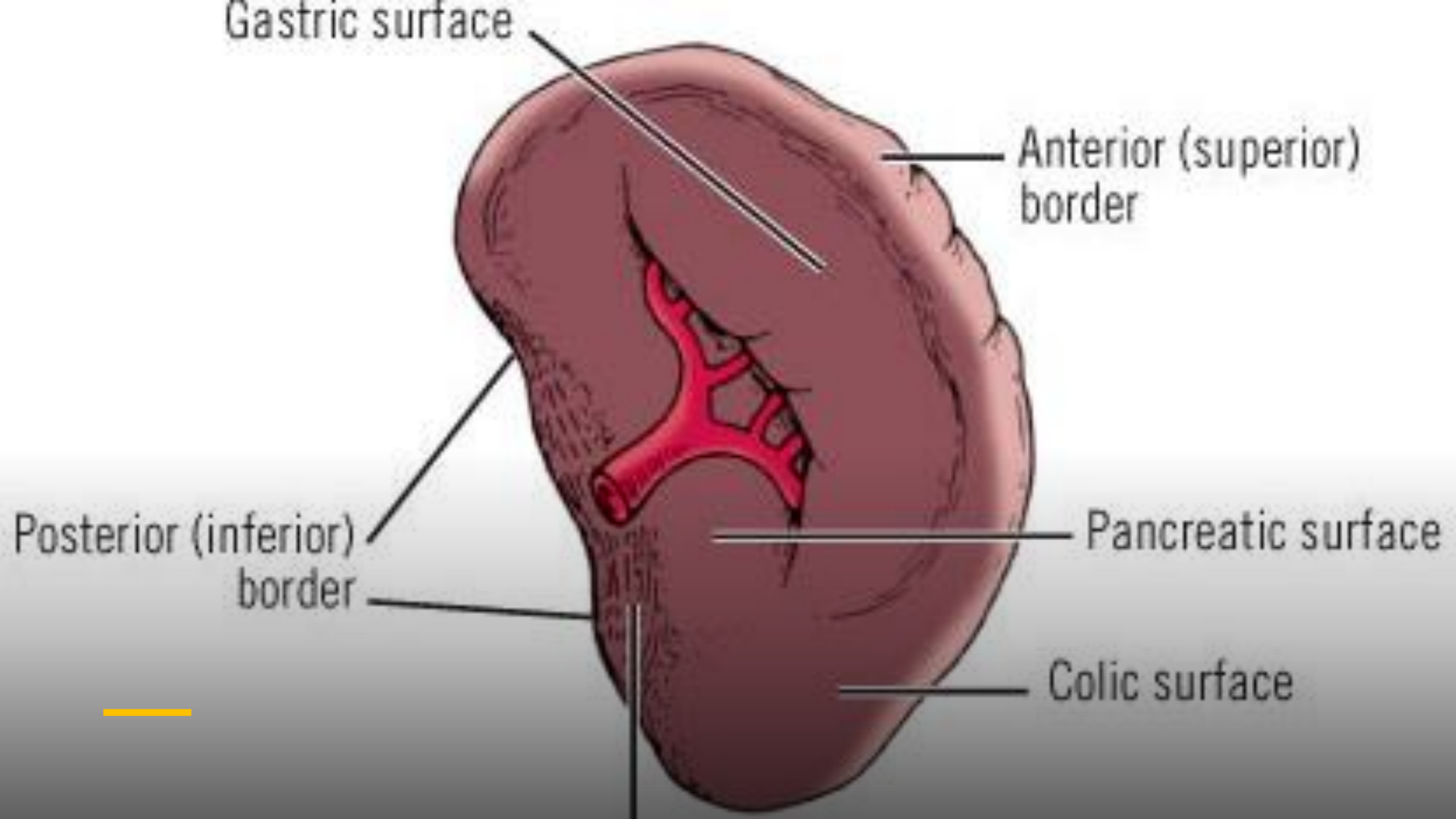
- Lymph Drainage.

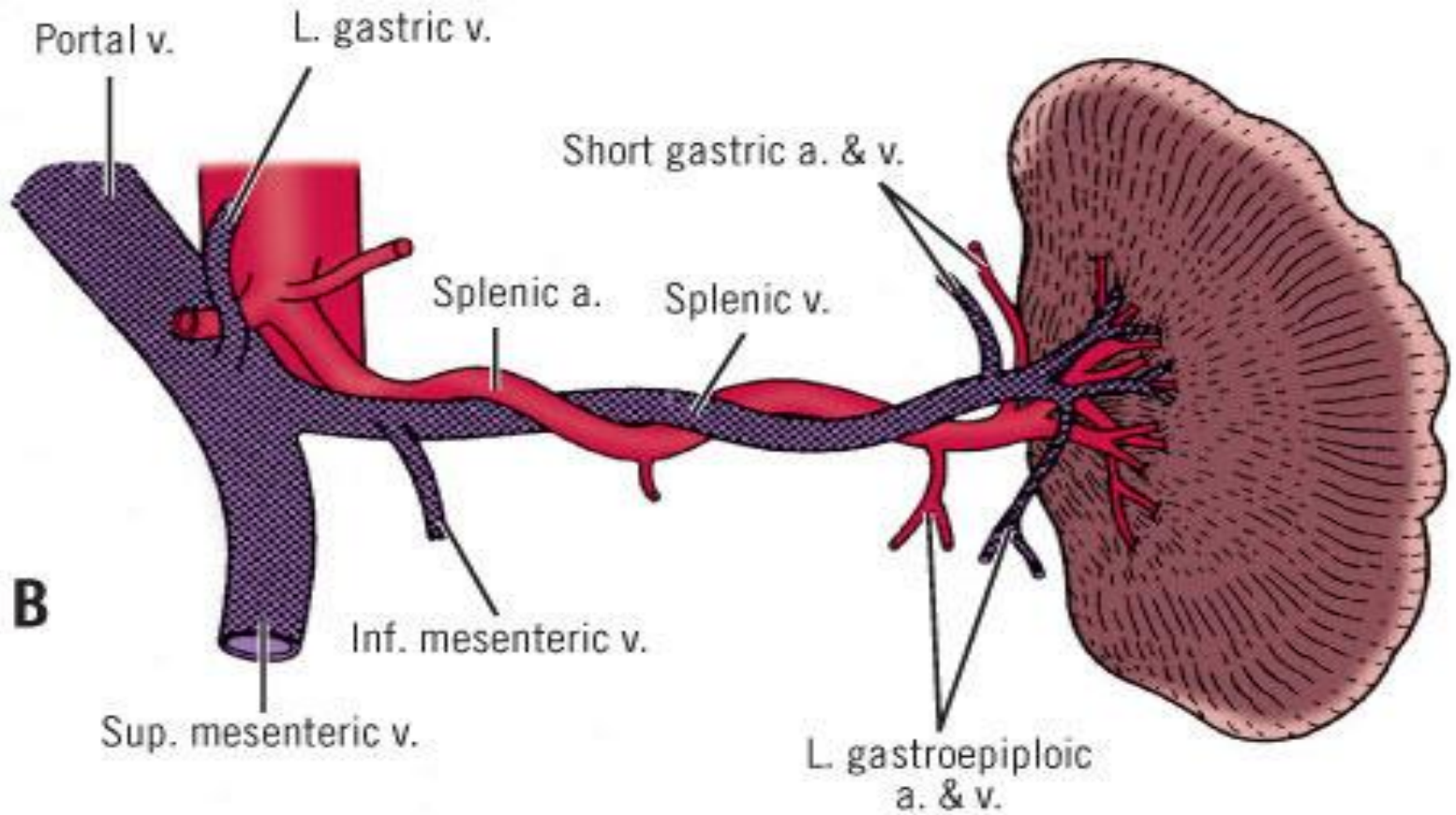
The lymph vessels emerge from the hilum and pass through a few lymph nodes along the course of the splenic artery and then drain into the celiac nodes.

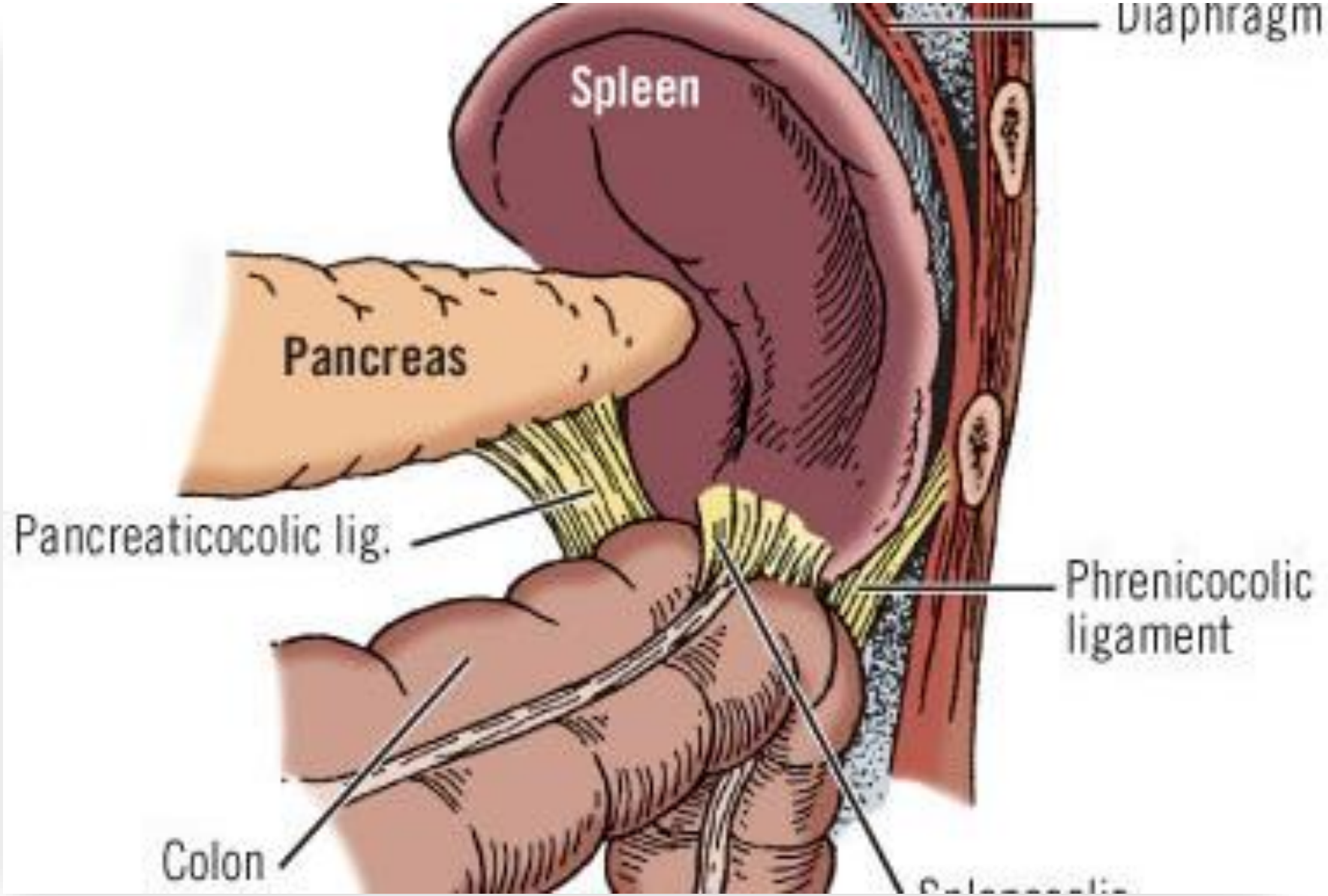
- Nerve Supply

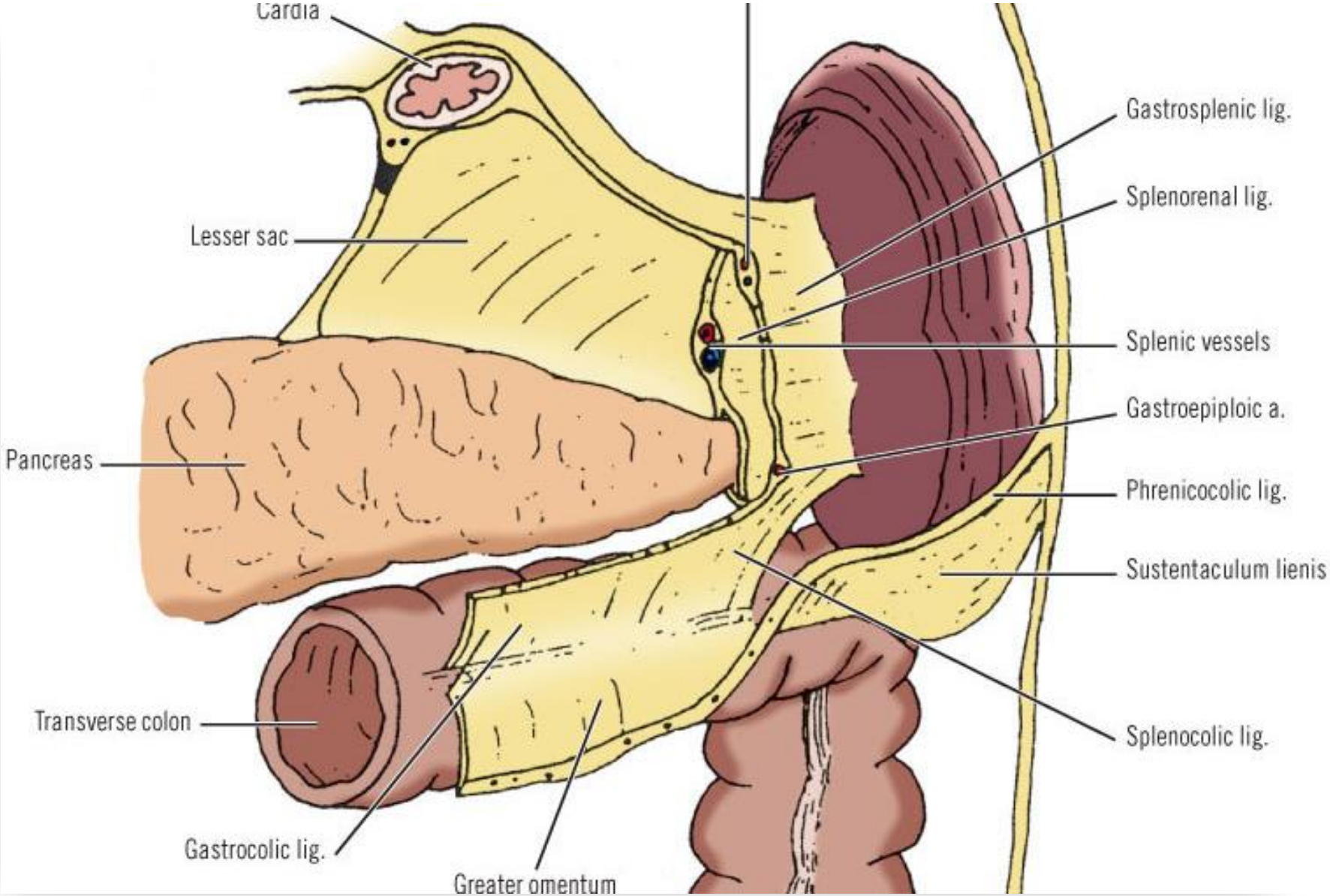
The nerves accompany the splenic artery and are derived from the celiac plexus.




Gastric surface
Anterior (superior) border
Posterior (inferior) border
Pancreatic surface
Colic surface




Diaphragm
Spleen
Pancreas
Pancreaticocolic lig.
Phrenicocolic ligament
Colon


Cardia
Lesser sac
Pancreas
Transverse colon
Gastrocolic lig.
Greater omentum
Gastrosplenic lig.
Splenorenal lig.
Splenic vessels
Gastroepiploic a.
Phrenicocolic lig.
Sustentaculum lienis
Splenocolic lig.

NERVE SUPPLY

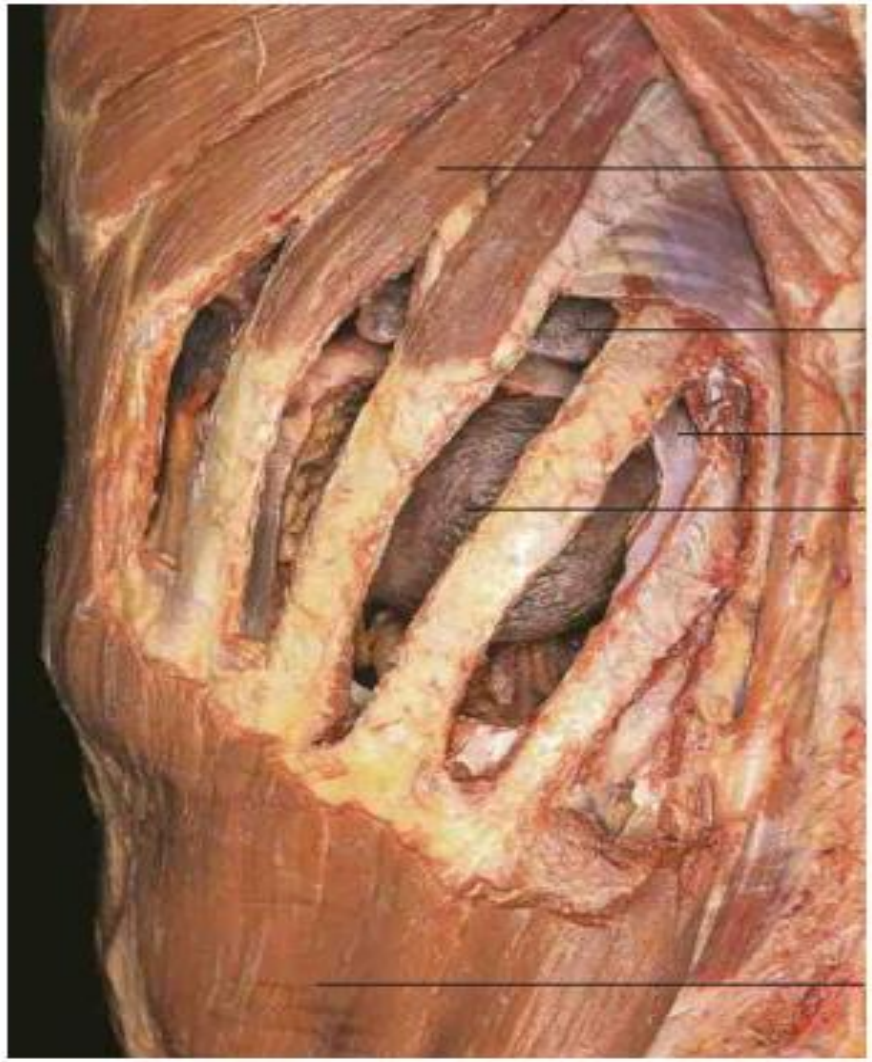
- Lymph drainage.

The lymph vessels emerge from the hilum and pass a few lymph nodes along the cross of the splenic artery and then drain into the celiac nodes.

- Nerve supply.

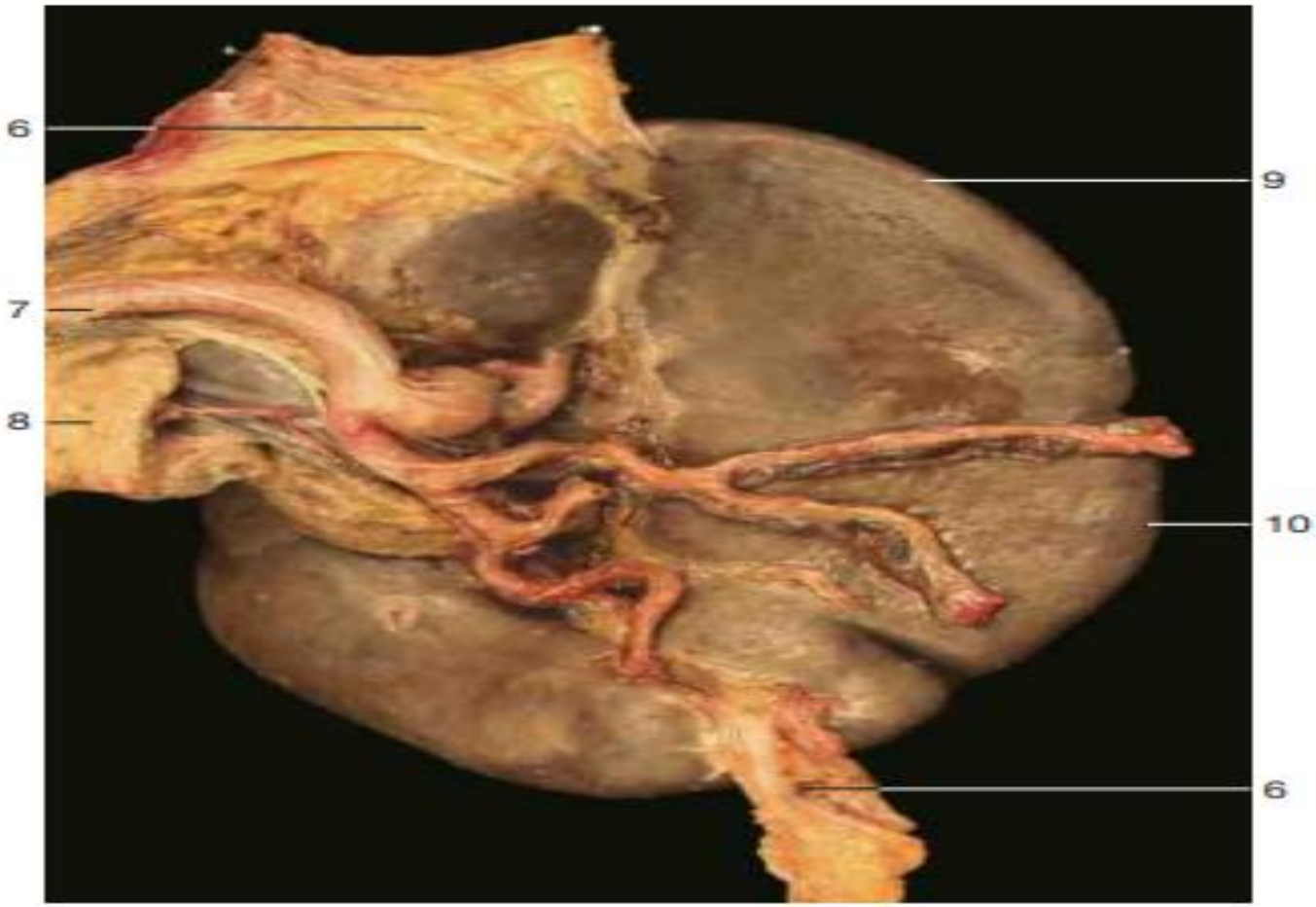
The nerves accompany the splenic artery and are derived from the celiac plexus.

CADAVERIC DISSECTION



1 Serratus anterior muscle
2 Left lung
3 Diaphragm
4 Spleen
5 External abdominal oblique muscle
6 Gastrosplenic ligament
7 Splenic artery
8 Pancreas tail
9 Superior margin of spleen
10 Anterior border of spleen
11 Liver
12 Hepatic artery proper
13 Cystic duct
14 Gallbladder
15 Lesser duodenal papilla (probe)
16 Greater duodenal papilla (probe)
17 Duodenum (fenestrated)
18 Cardia
19 Pancreas and pancreatic duct
20 Kidney (with capsula adiposa, capsular fat, adipose tissue)
21 Common bile duct
22 Superior mesenteric artery and vein
23 Ureter
24 Aorta with celiac trunk
25 Suprarenal gland
26 Inferior mesenteric vein

Location of the spleen in situ (left-lateral aspect).
Intercostal spaces and diaphragm have been fenestrated.



Spleen (visceral surface), hilum of spleen with vessels, nerves, and ligaments.