MD Program
UNIVERSITY OF TORONTO

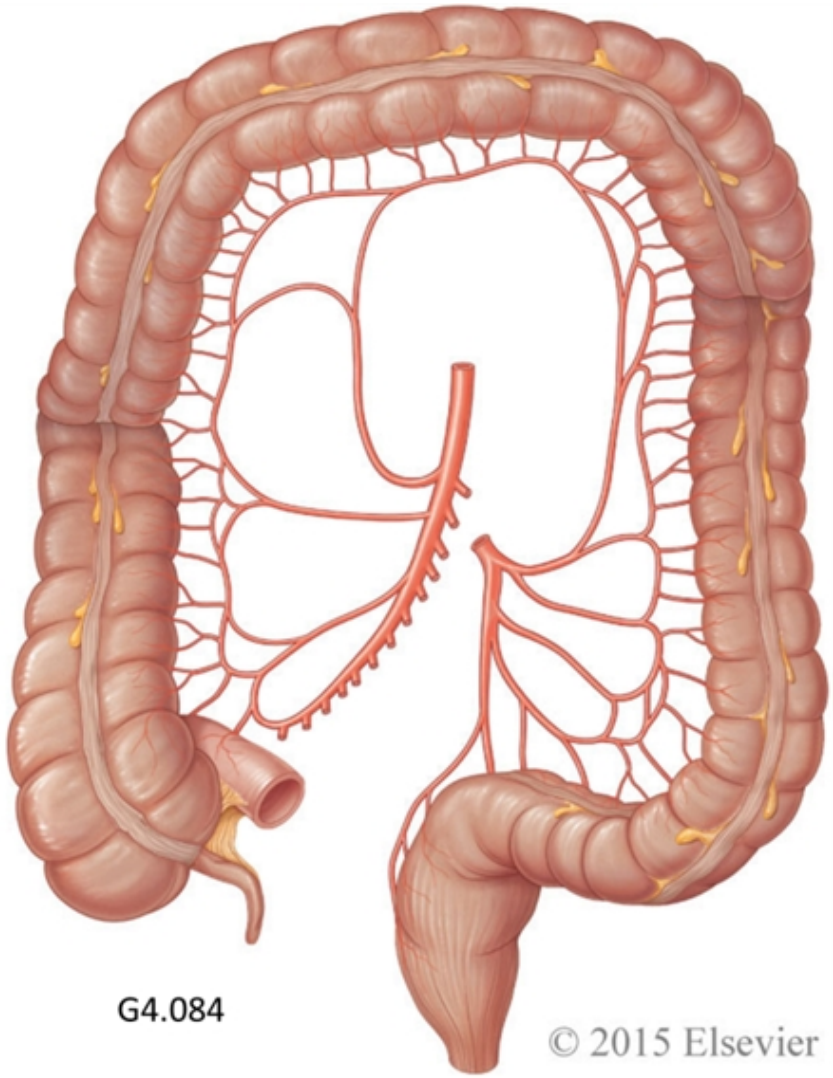
Anatomy

UNIT 4: Abdomen, Pelvis & Perineum
Lab 12

CLICK TO ENTER

12A Prelab SLM: The Midgut and Hindgut

Complete this prelab SLM **prior to** the lab. You will be quizzed on its contents at the start of Lab 12.



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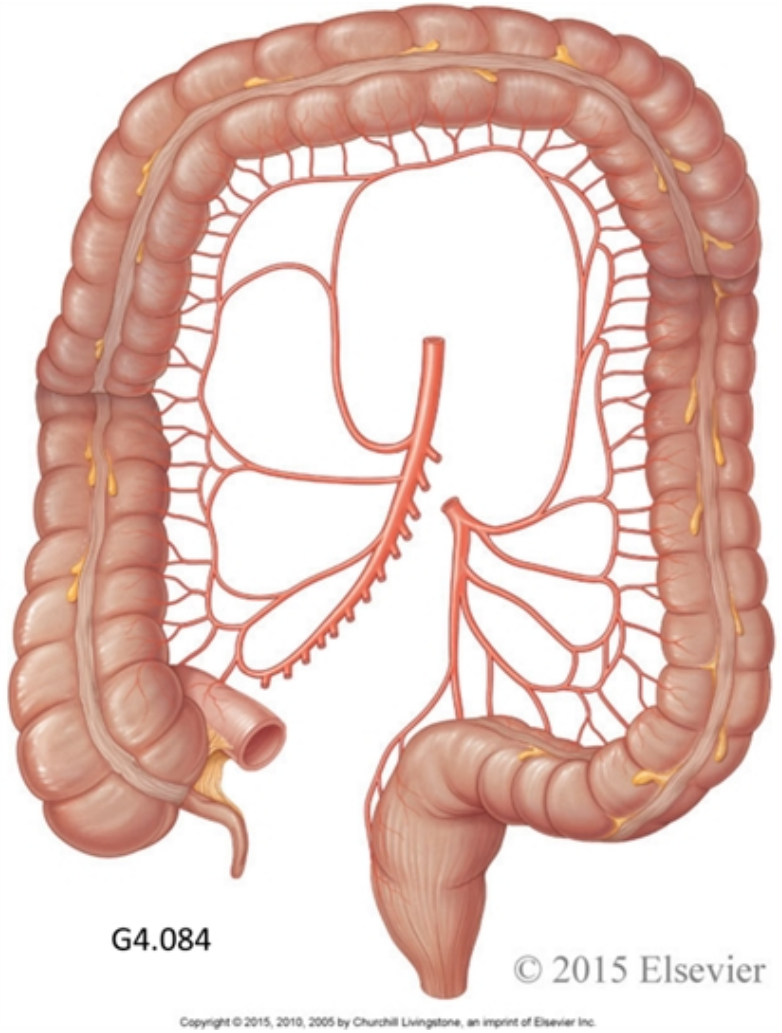
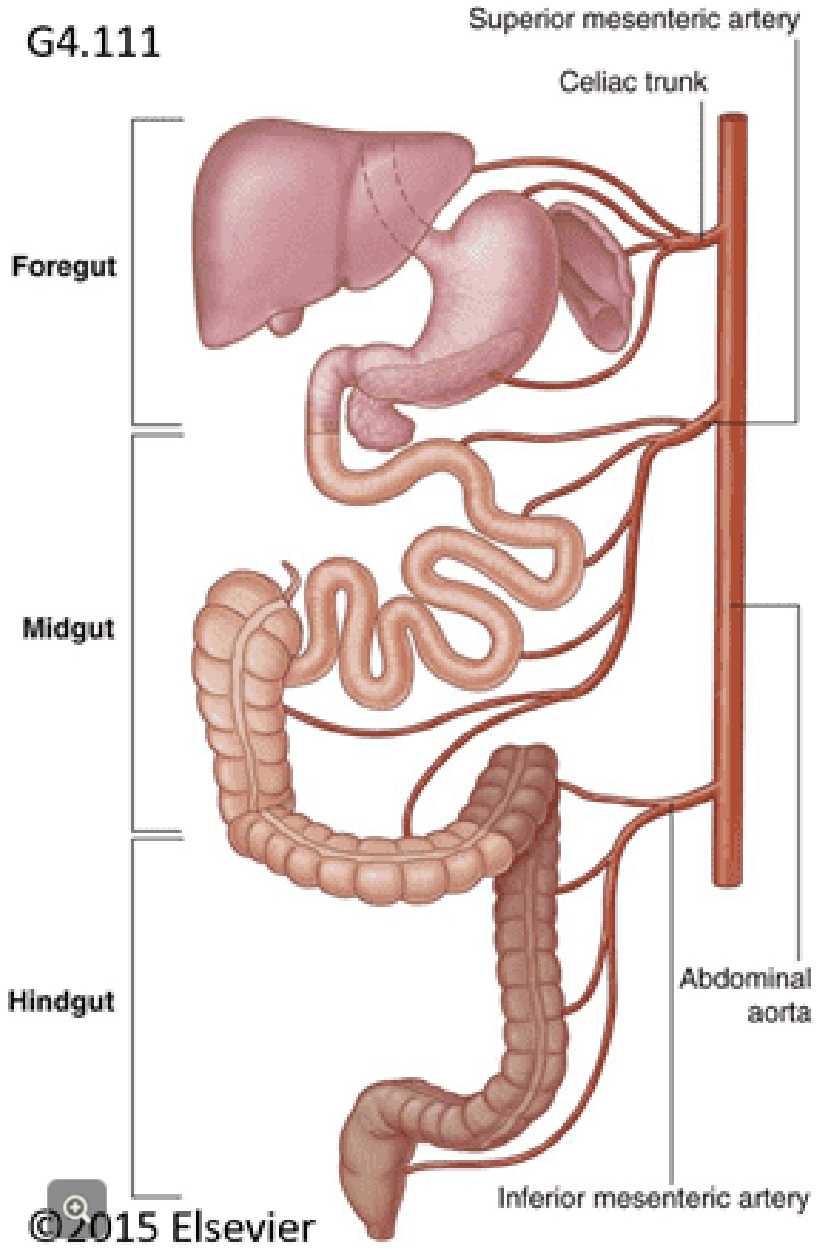
When you have completed this prelab SLM, you will be able to describe:

- the location and gross features of the jejunum, ileum and large intestine.
- the mesentery of the small intestine, the transverse mesocolon and the sigmoid mesocolon, and the structures contained therein.
- the superior mesenteric artery (SMA) and its branches that supply the distal duodenum and pancreas, the jejunum, ileum, cecum, appendix, ascending and transverse colon.
- the inferior mesenteric artery (IMA) and its branches that supply the descending and sigmoid colon, and the rectum.
- the anastomoses between the foregut and midgut, and between the midgut and hindgut.
- the hepatic portal vein and its tributaries.
- the lymphatic drainage of the digestive tract
- the parts of the duodenum, their location, relationships and course.
- the parts of the pancreas, their location, relationships and course.





The digestive tract is a single (albeit convoluted) tube that has three subdivisions, based on its embryological development: **the foregut, midgut and hindgut**. Each subdivision receives its blood supply from one of **three, unpaired, visceral branches of the abdominal aorta:**

- The **foregut** receives blood from the **celiac trunk**, and includes the **stomach, spleen, liver, gallbladder** and **proximal duodenum and pancreas**.
- The **midgut** receives blood from the **superior mesenteric artery**, and includes the **distal pancreas** and **duodenum**, the remainder of the **small intestine**, and the **ascending** and initial portion of the **transverse colon**.
- The **hindgut** receives blood from the **inferior mesenteric artery**, and includes the remainder of the **transverse colon**, the **descending** and **sigmoid colon,** and the **rectum**.

These three vessels arise from the aorta in the posterior body wall, i.e. retroperitoneally. In order for their branches to gain access to **intraperitoneal organs**, they must pass through **mesenteries** or **ligaments**.

The Superior Mesenteric Artery and Midgut

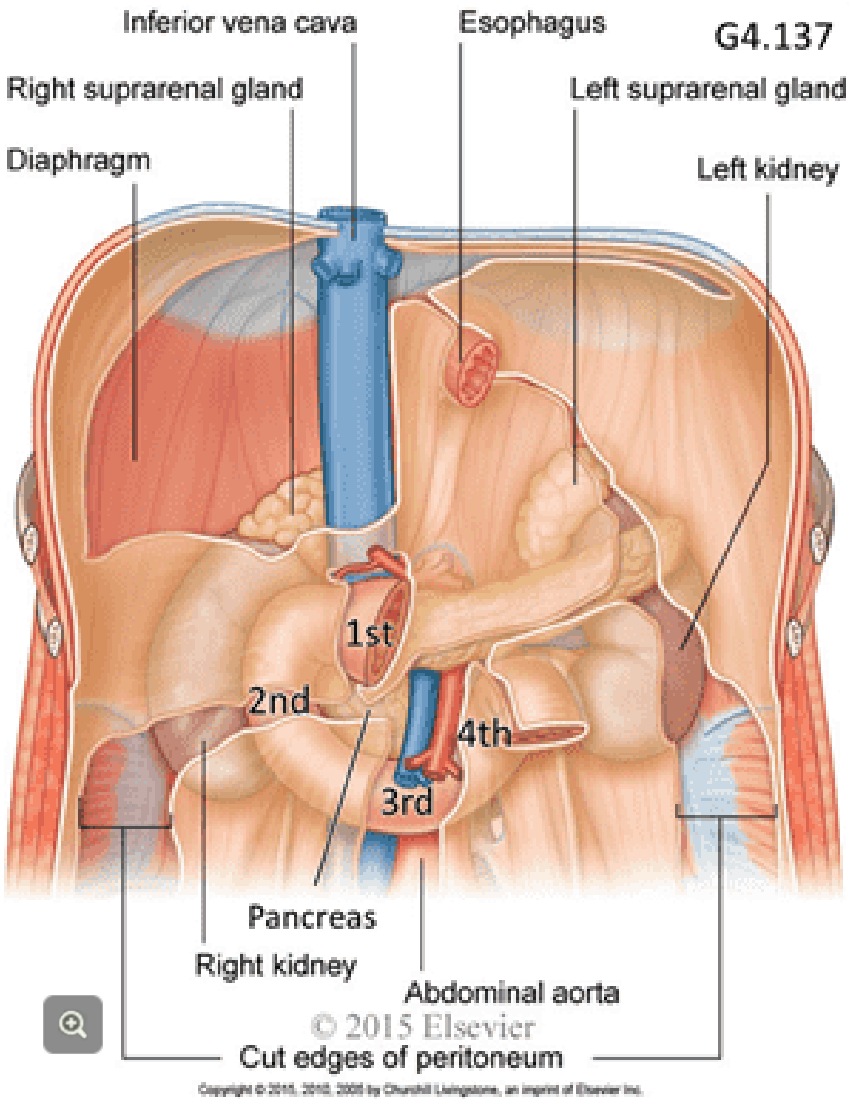
The small intestine is 6-7 m long, tapering from proximal to distal. The **duodenum**, the first part of the small intestine, is 20-25 cm long. **The division between the foregut and midgut passes through the duodenum and pancreas**.

Trace the duodenum in the accompanying illustration; note that it is subdivided into **1st (superior), 2nd (descending), 3rd (transverse)** and **4th (ascending) parts**.

The proximal 2 cm of the 1st part is intraperitoneal and therefore mobile. **This is the portion that is attached to the hepatoduodenal ligament**. **The remainder of the duodenum is secondarily retroperitoneal**; you will study it directly when you dissect this region.

Take note in the illustration that the "head" of the pancreas lies in the curve of the duodenum and its "tail" extends toward the superior left quadrant of the abdomen, where it meets the hilum of the spleen.

The **proximal duodenum** and **portions of the pancreas** are supplied by branches of the **celiac trunk**, and are therefore **foregut** derivatives. The **distal duodenum** and **portions of the pancreas** are supplied by branches of the **SMA**, and are therefore **midgut** derivatives. See here.



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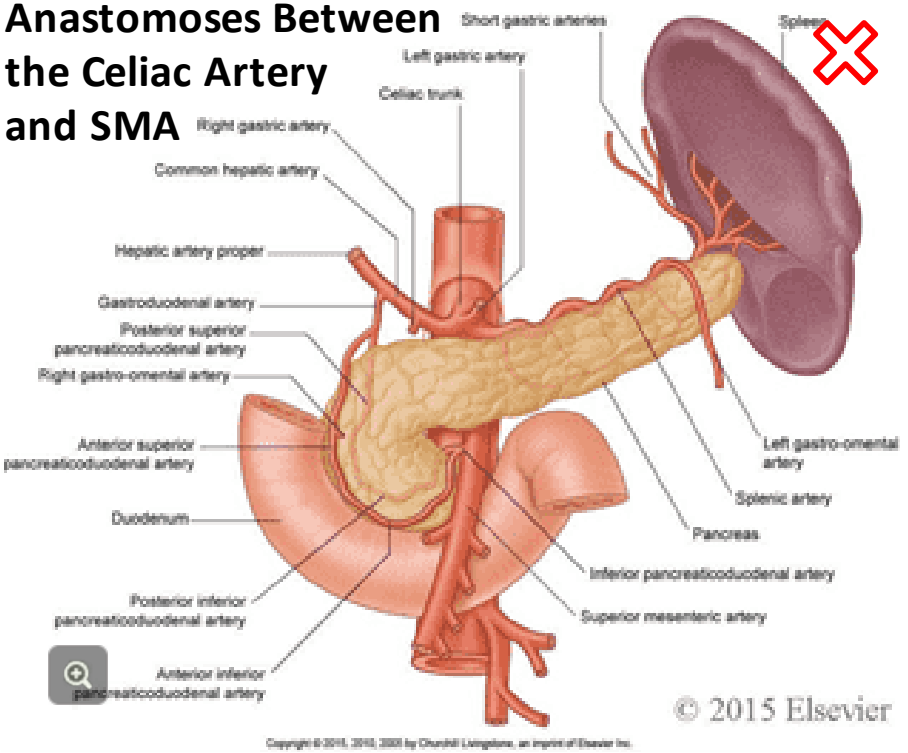
Anastomoses Between the Celiac Artery and SMA



The major anastomosis between the SMA and the celiac artery is via the **superior and inferior pancreaticoduodenal arteries**.

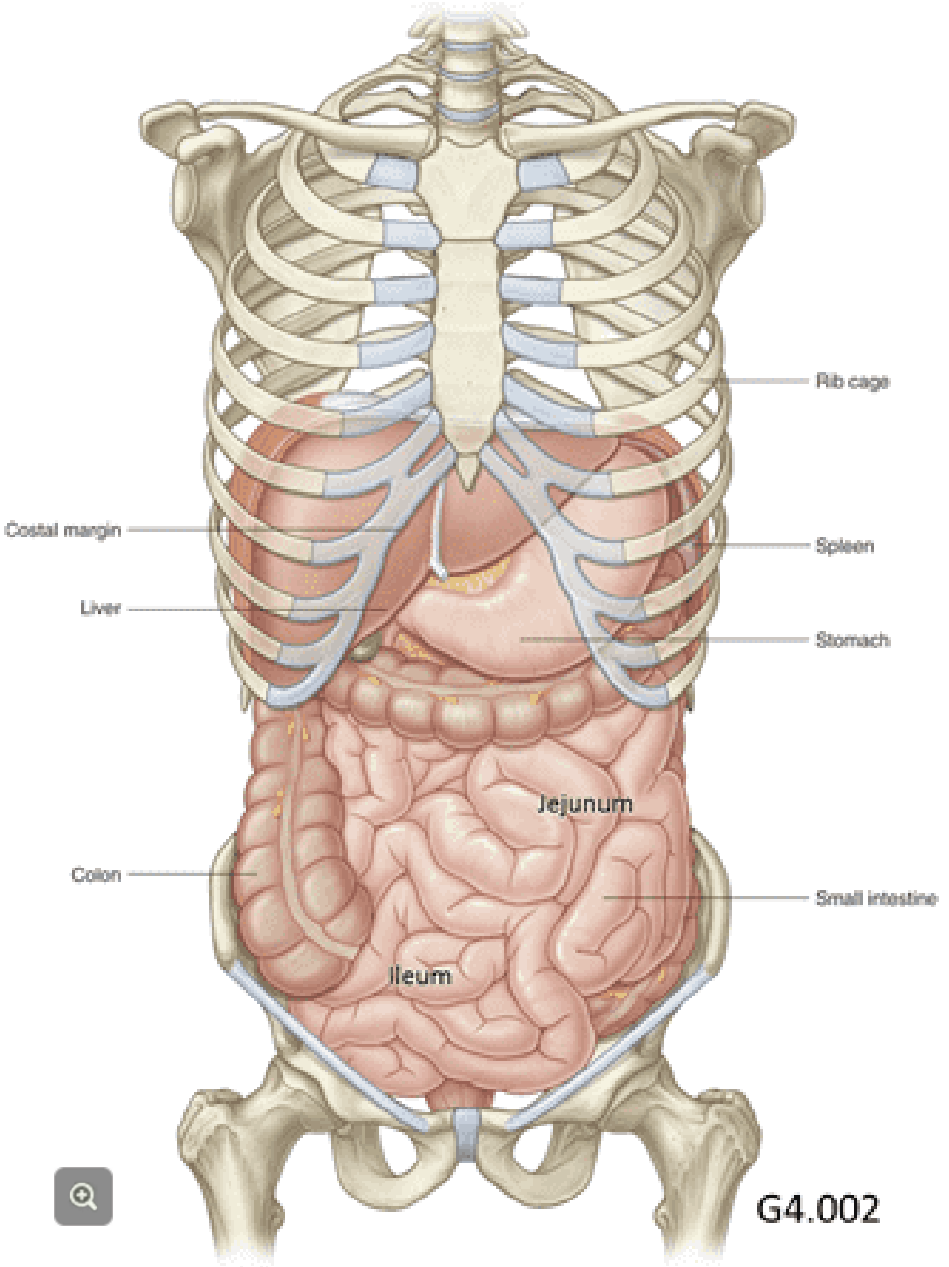
The superior pancreaticoduodenal arteries arise from branches of the **celiac artery**. The inferior pancreaticoduodenal arteries arise from the **SMA**.

These vessels anastomose to supply the pancreas and duodenum with blood.

Distal to the duodenum, the **jejunum** and **ileum** comprise the remainder of the small intestine, the jejunum being the proximal 2/5 and the ileum the distal 3/5.

The duodenojejunal junction is abrupt: **the jejunum begins where the duodenum leaves the retroperitoneum to acquire a mesentery**. In contrast, the transition from jejunum to ileum is **gradual**, and is based on both histology and gross anatomy. The ileum ends abruptly where it meets the cecum at the **ileocecal junction**. There, the **ileocecal valve** controls the movement of intestinal contents from the small intestine to the large intestine.

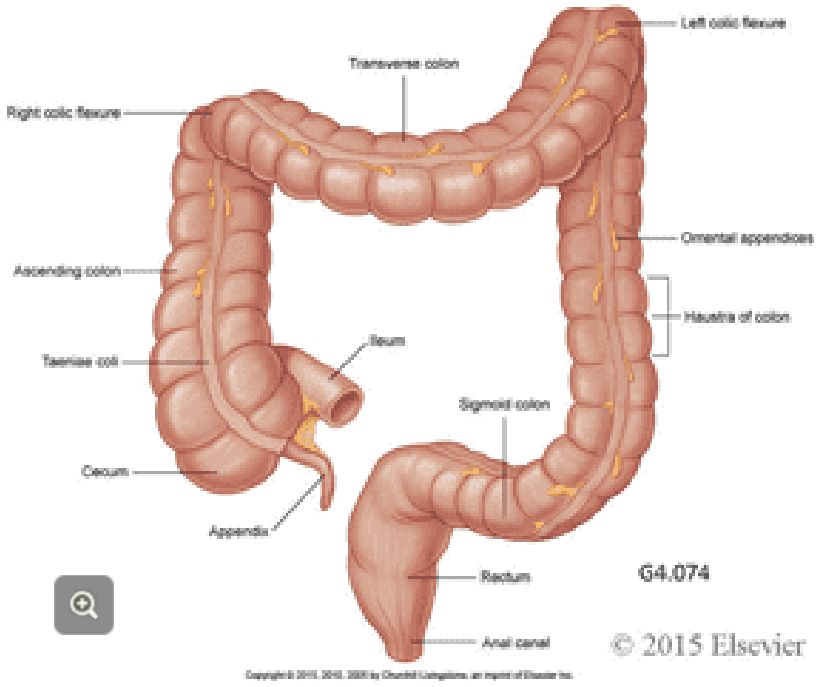
In the accompanying illustration, note the loops of small bowel occupying most of the **infracolic compartment**. Notice that in general, the **jejunum** occupies the **upper left** portion of the infracolic compartment, and the **ileum** occupies the **lower right** portion of the infracolic compartment



The large intestine is **1.5 m long** and extends from the **cecum** to the **anus**. It functions to **absorb water** and **salt** from the luminal contents to form **feces**. It includes the **cecum, appendix, colon, rectum** and **anal canal**.

The **colon** is subdivided into the **ascending, transverse, descending** and **sigmoid colon.** The ascending colon becomes the transverse colon at the **right colic flexure (hepatic flexure)** and the transverse colon becomes the descending colon at the **left colic flexure (splenic flexure)**.

The **ascending** and **descending colon**, being **secondarily retroperitoneal**, are fixed to the posterior abdominal wall. The peritoneal spaces lateral to the ascending and descending colon are the **right and left paracolic gutters**. **Fluid may accumulate in these spaces in a supine individual, and channel though these spaces with upright posture.**



The transverse and sigmoid colon are intraperitoneal and supported by their mesenteries, the **transverse** and **sigmoid mesocolon**, respectively.

At the gross anatomical level, the colon is distinguished from the small intestine by i) its **larger diameter**, ii) by the presence of **epiploic (omental) appendages**, tags attached to the colon composed of fat enclosed in peritoneum, iii) by the presence of **teniae coli**, three longitudinal strips of smooth muscle that comprise the outer layer of its muscularis externa, and iv) by the presence of **haustra**, the sacculations of the large bowel formed by contraction of the teniae coli.

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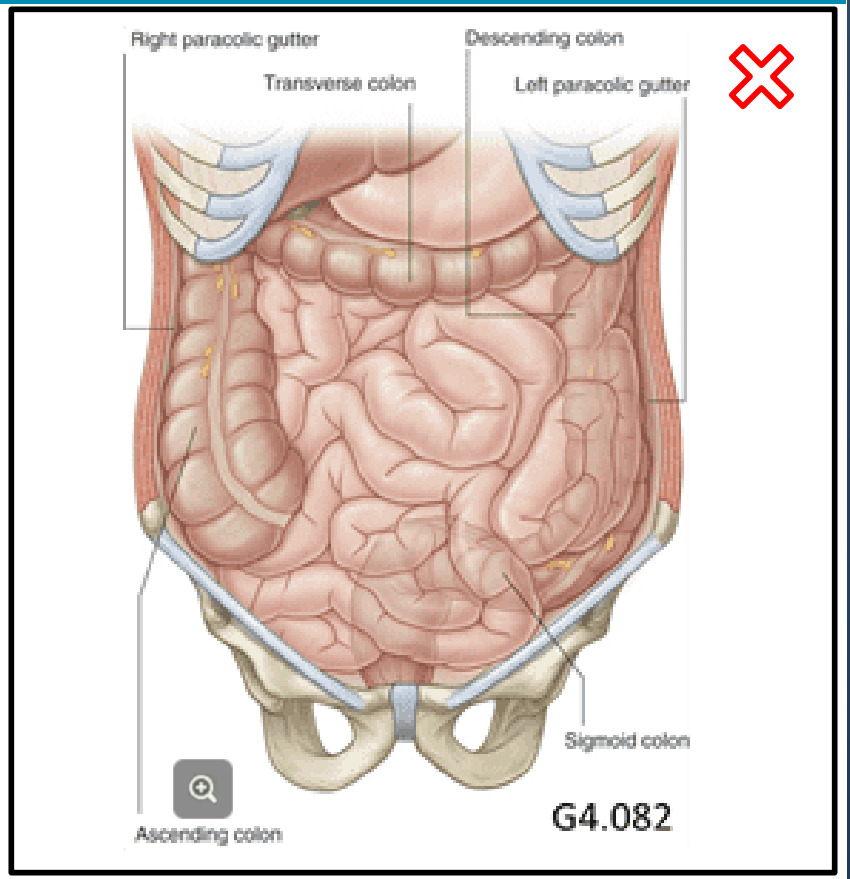

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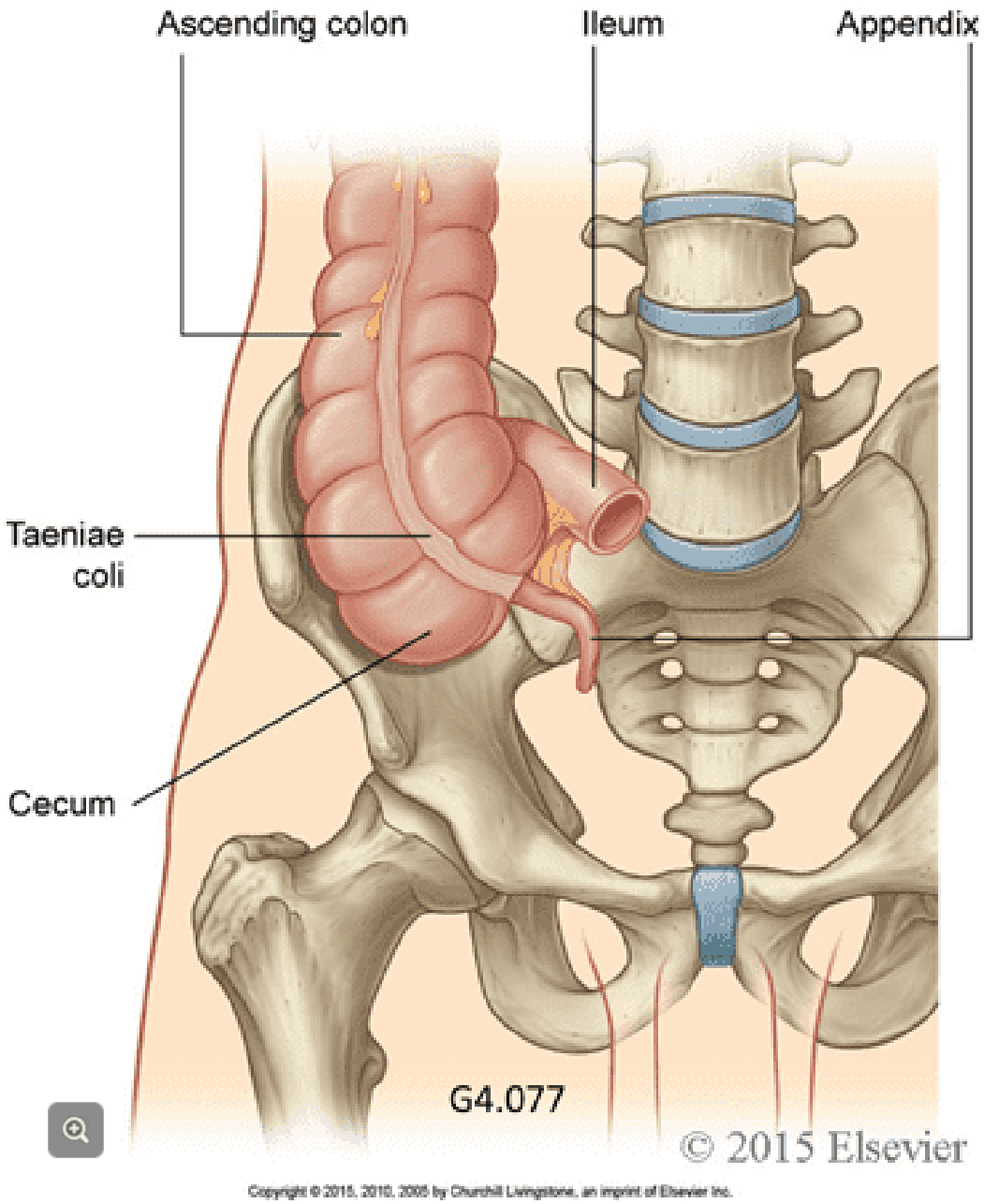
The cecum is that portion of the colon **inferior to the ileocecal junction**. It is usually located in the **right iliac fossa**, although it may cross the pelvic brim and lie in the **true pelvis**.

The vermiform appendix attaches to the posteromedial aspect of the cecum, inferior to the ileocecal junction, at the base of a tenia coli.

While its point of attachment is circumscribed, the location of the appendix itself is variable. It is **retrocecal** in almost 2/3 of people and **pelvic** in most of the remaining 1/3.

The **mesoappendix** is a mesentery that attaches the appendix to the terminal ileum. It contains the **appendicular vessels**.



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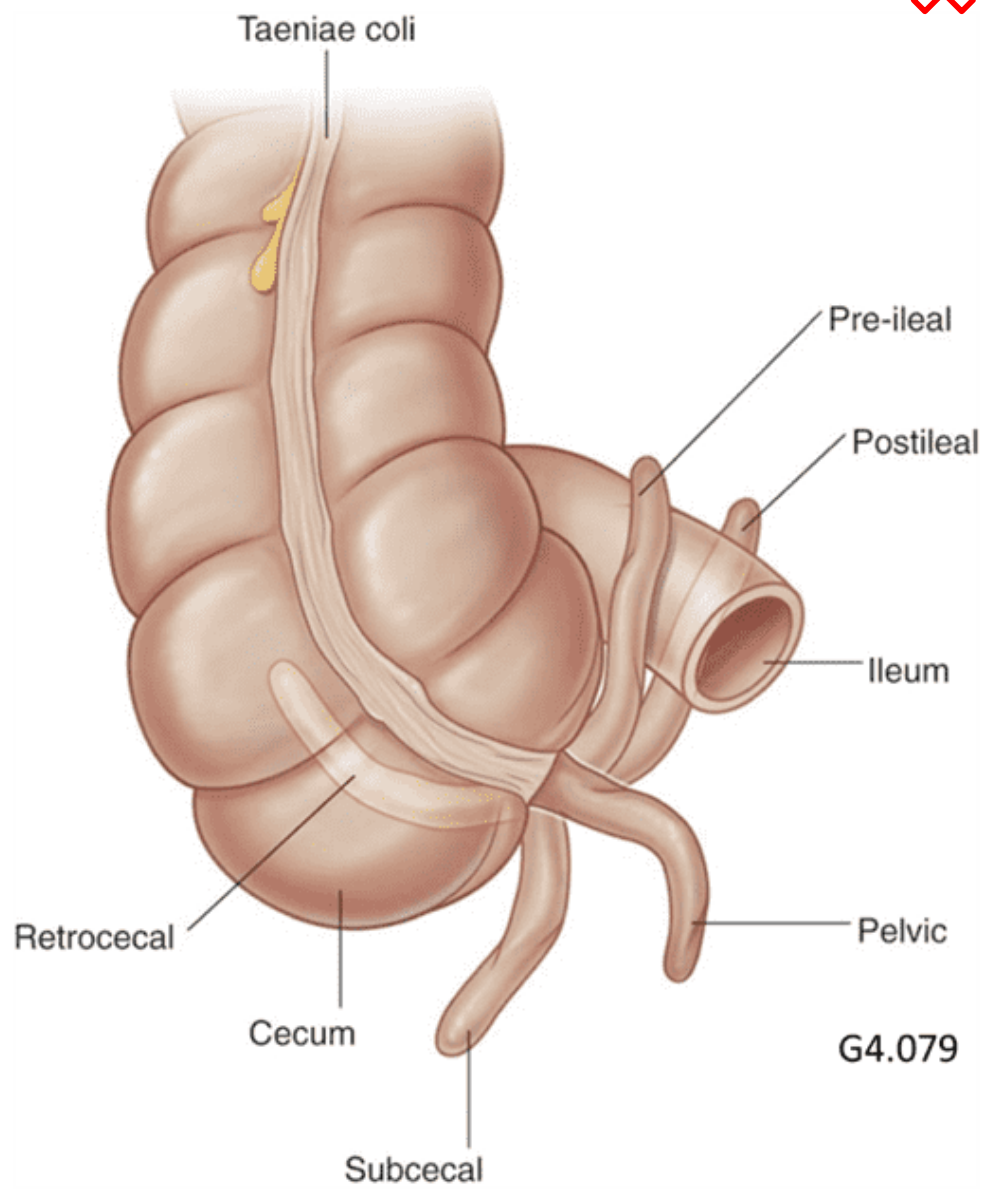
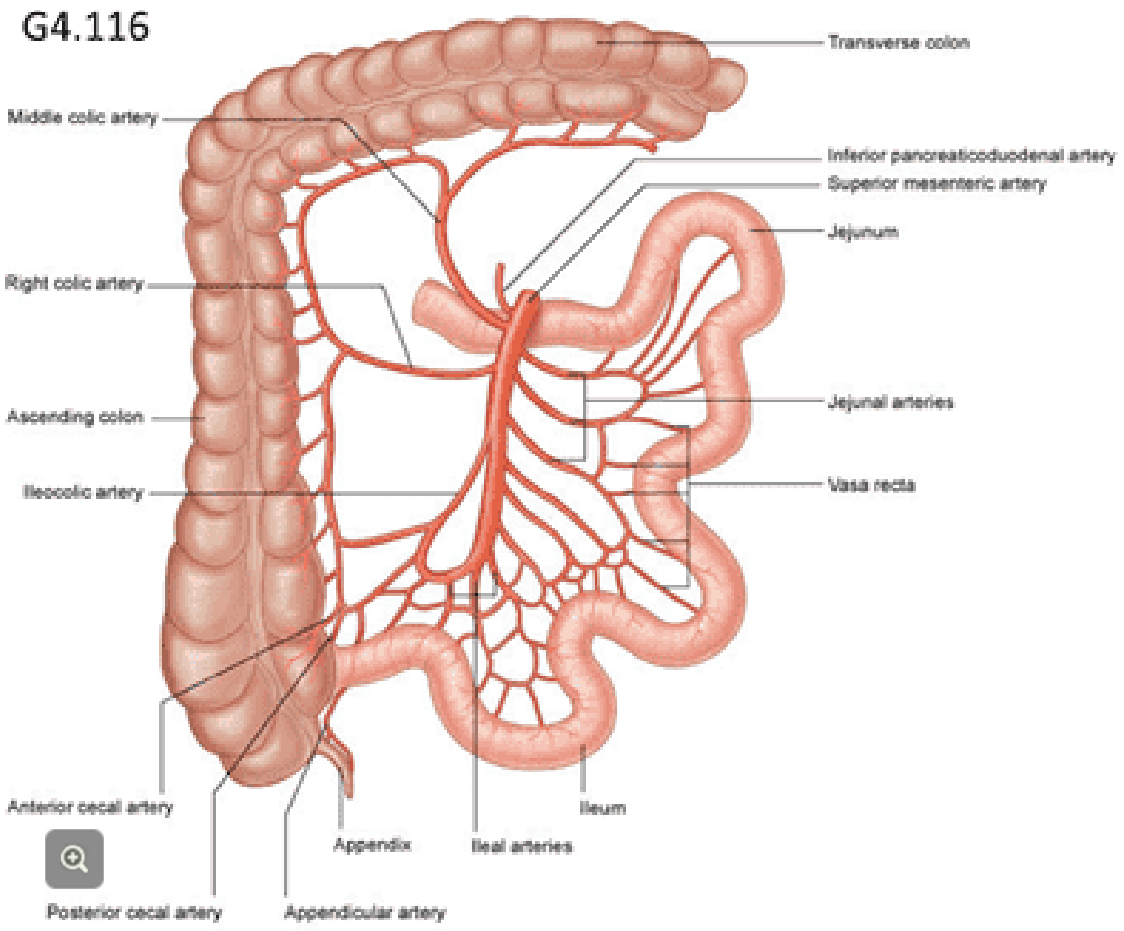
The Position of the Appendix



The SMA arises from the anterior aspect of the abdominal aorta at the level of the L1 vertebra, **1 cm below the origin of the celiac trunk**. The **first branch of the SMA**, the inferior pancreaticoduodenal artery, arises retroperitoneally to supply a portion of the **pancreas** and the **distal duodenum**. The SMA then continues in a retroperitoneal position, **anterior to the third (horizontal) part of the duodenum and left renal vein** It then **enters the mesentery**.



In the accompanying illustration, note the (retroperitoneal) course of the SMA over the **horizontal portion (3rd part) of the duodenum**.

Once the SMA enters the mesentery, the **jejunal** and **ileal arteries** arise from its **left side**.

Contrast this with its **branches to the large intestine** (ileocolic, right colic and middle colic As), which **arise from its right side**.

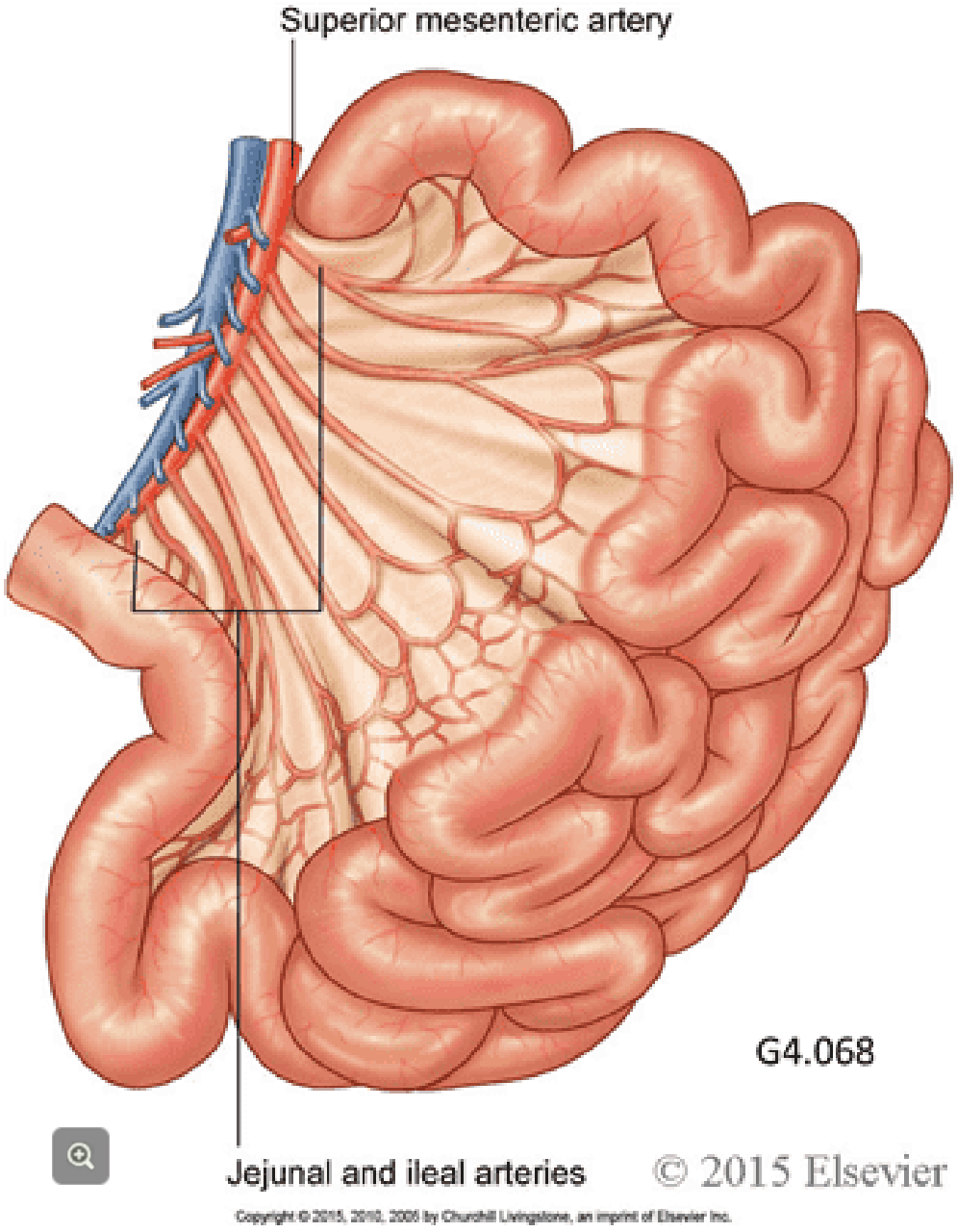
Know that these arteries are accompanied by **veins that take the same name**.

The **root of the mesentery** is its line of attachment to the posterior abdominal wall. It passes along a 15 cm-long oblique line extending from the **upper left** to the **lower right** quadrants, roughly **from the duodenojejunal junction to the ileocecal junction**. Within the root of the mesentery runs the **superior mesenteric artery and vein**, with the vein to the right of the artery.

Together, the jejunum and ileum are 6 m long. Since the mesentery attaches along this length, therefore, at its attachment to the jejunum and ileum, the mesentery is over 6 m long.

Thus the mesentery expands rapidly from a length of **15 cm at its root** to a length of **6 m along its line of attachment to the jejunum and ileum**. It is thus shaped like an elaborate folding fan.

Once again, in this illustration, notice that the **jejunal and ileal branches** of the SMA and SMV extend from their left side to the small bowel.



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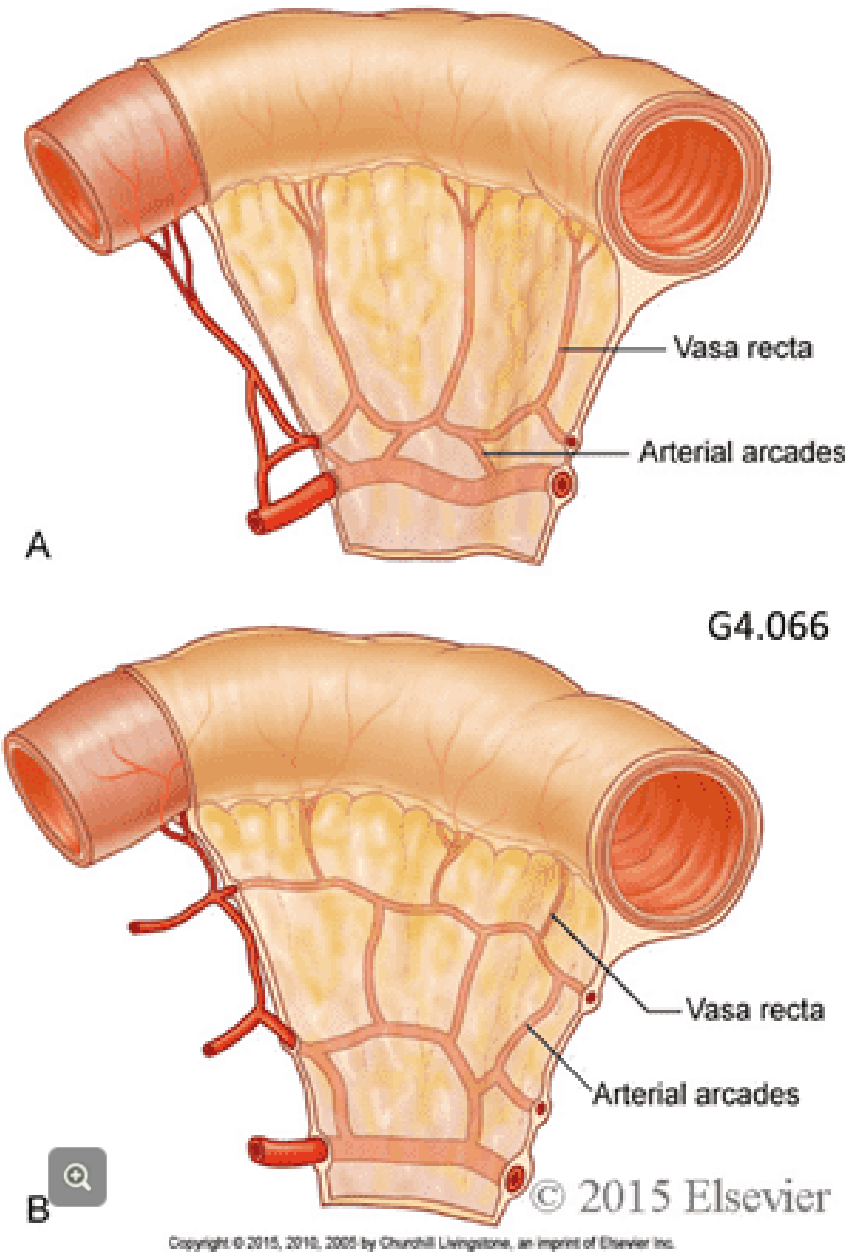
Fifteen to eighteen jejunal and ileal arteries arise from the left side of the SMA to form intestinal **arcades**. These arching vessels form a network within the mesentery from which **vasa recta** arise to supply the intestine.

The characteristic architecture of the jejunal vessels is distinctly different from that of the ileal vessels. The **jejunum has a simpler network of arcades that give rise to longer vasa recta (A)**, while the **ileal arcades are much more complex, and give rise to shorter vasa recta (B).**



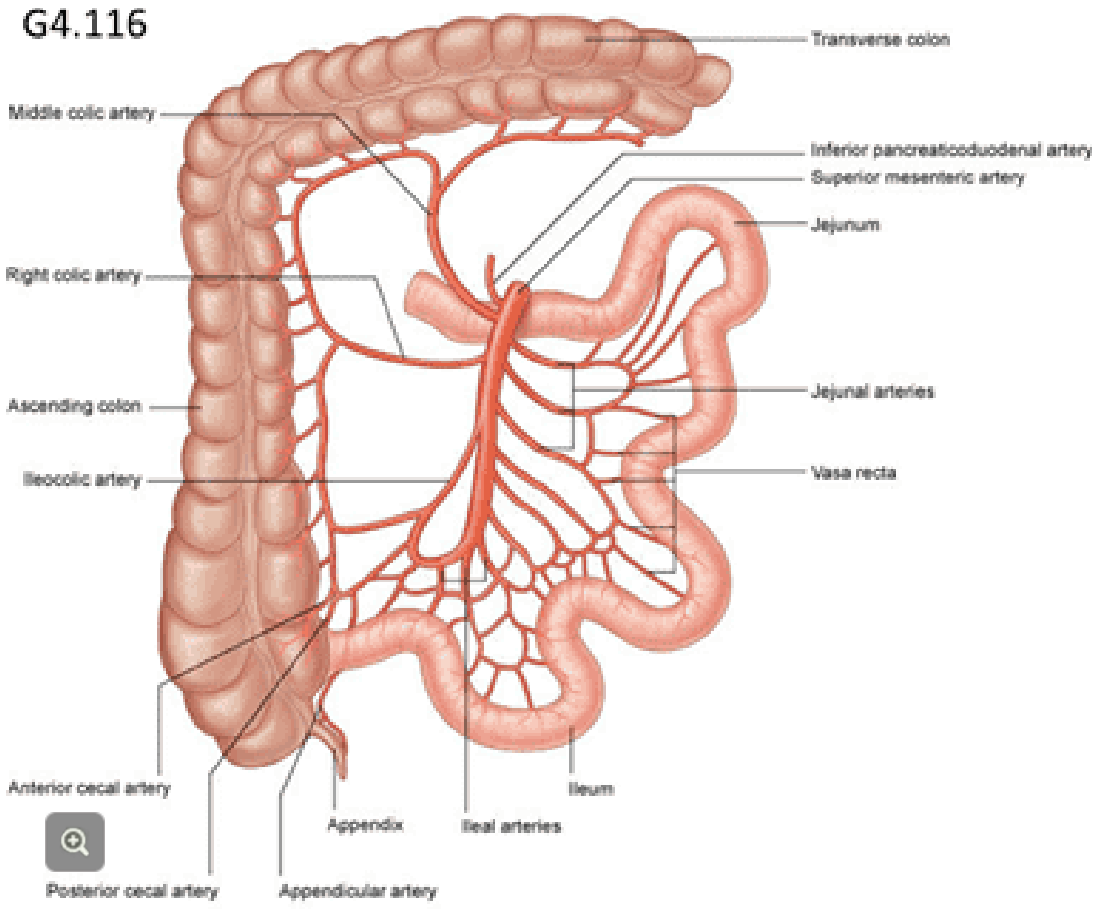
Colic branches of the SMA arise from its right side. These are the **ileocolic artery** to the ileocecal junction, the **right colic artery** to the ascending colon and the **middle colic artery** to the transverse colon.

The ileocolic artery courses obliquely, in a retroperitoneal position, toward the **cecum**. It gives rise to the **appendicular artery**, which runs within the **mesoappendix**. The ileocolic artery anastomoses with **intestinal branches** to the ileum and with the **right colic artery**.

The right colic artery runs in a retroperitoneal position to the (retroperitoneal) **ascending colon**. Its inferior branch **anastomoses with the ileocolic artery** and its superior branch **anastomoses with the middle colic artery**.

The middle colic artery is one of the first branches of the SMA after the inferior pancreaticoduodenal artery. The middle colic artery enters the **transverse mesocolon** to supply the (intraperitoneal) **transverse colon**. It gives rise to right and left branches which **anastomose with the right colic artery** and the **left colic artery**, respectively.

The left colic artery is a branch of the **inferior mesenteric artery** which supplies the **descending colon**, a hindgut derivative.



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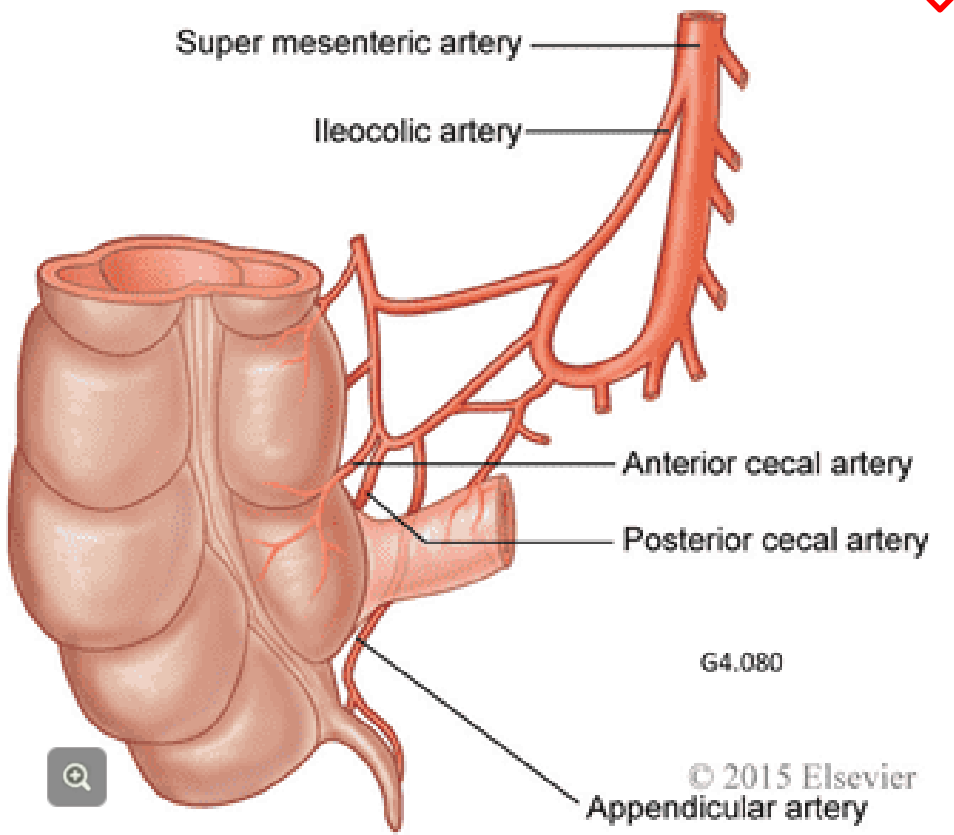
The Ileocolic Artery



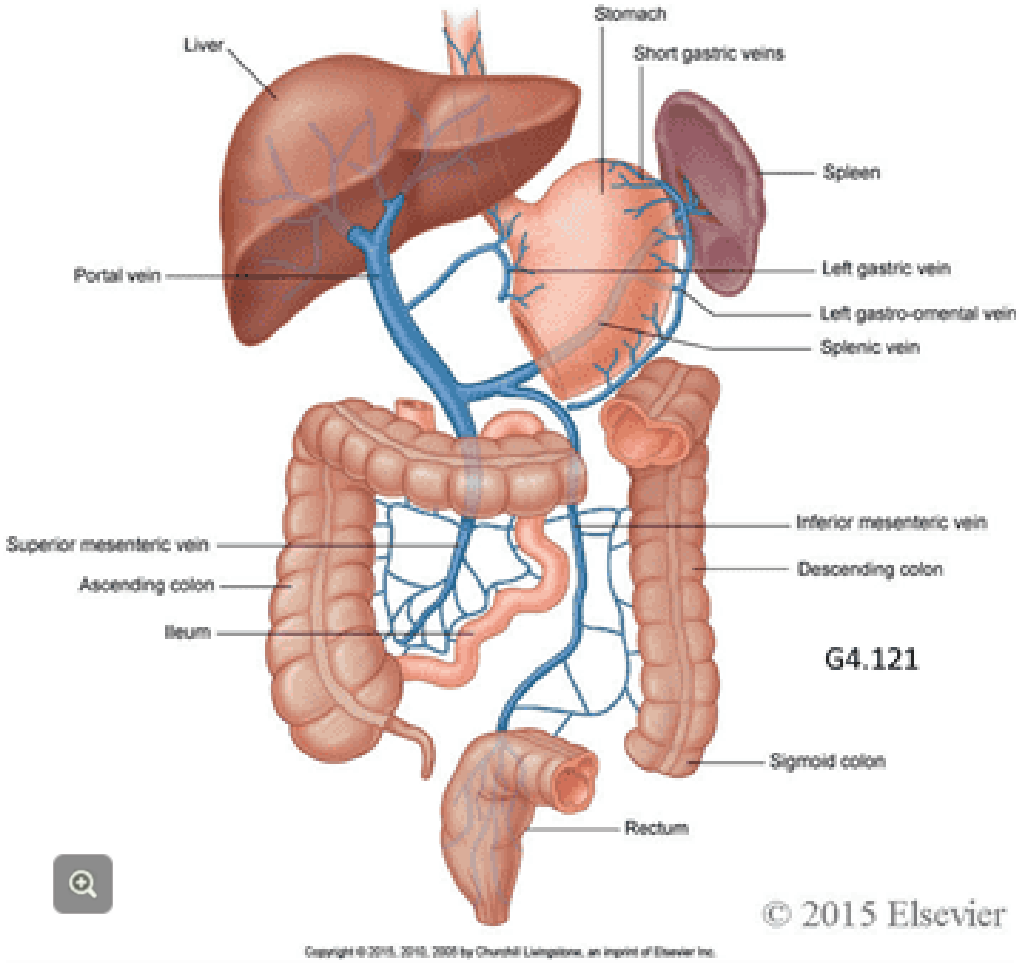
The **superior mesenteric vein** (SMV) is the venous companion to the SMA. The SMV is located to the right of the SMA, as the IVC is to the right of the aorta. The names of the tributaries of the SMV correspond to those of the companion artery.

Thus, there are **jejunal, ileal, ileocolic, right colic and middle colic veins** that drain into the SMV. The SMV ascends, in the companionship of the SMA, over the horizontal portion of the duodenum.

The SMV drains the midgut to the hepatic portal system, which transports venous blood from the digestive tract to the liver. Take note, from the illustration, the formation of the **hepatic portal vein** from the **union of the SMV with the splenic vein**.

Hundreds of lymph nodes occupy the field of the SMA within the mesentery, the retroperitoneum between the root of the mesentery and the ascending colon and the transverse mesocolon.

The lymphatic channels that drain this field follow the branches of the SMA to the **superior mesenteric lymph nodes** in the region of the **junction of the SMA with the abdominal aorta**.



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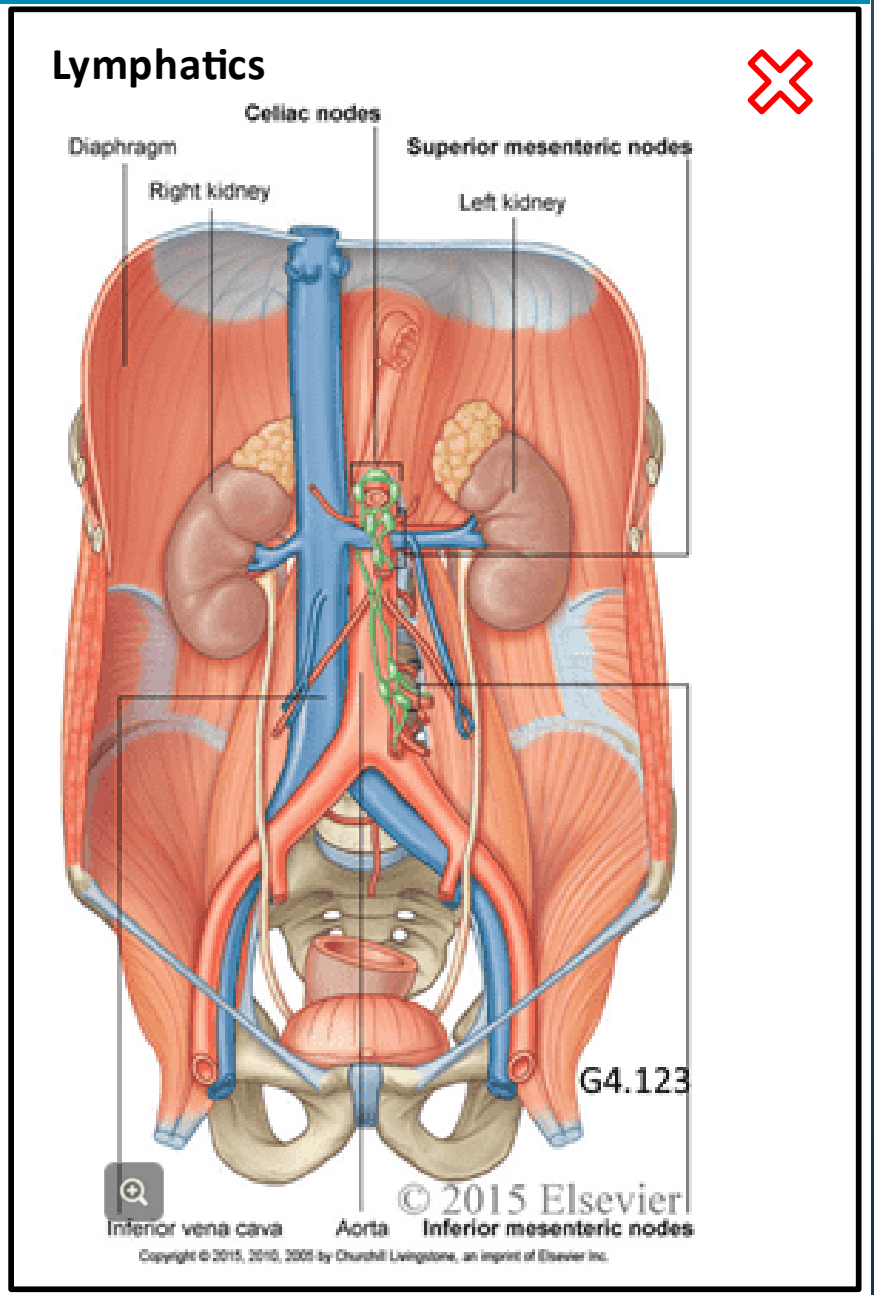


The Inferior Mesenteric Artery and Hindgut

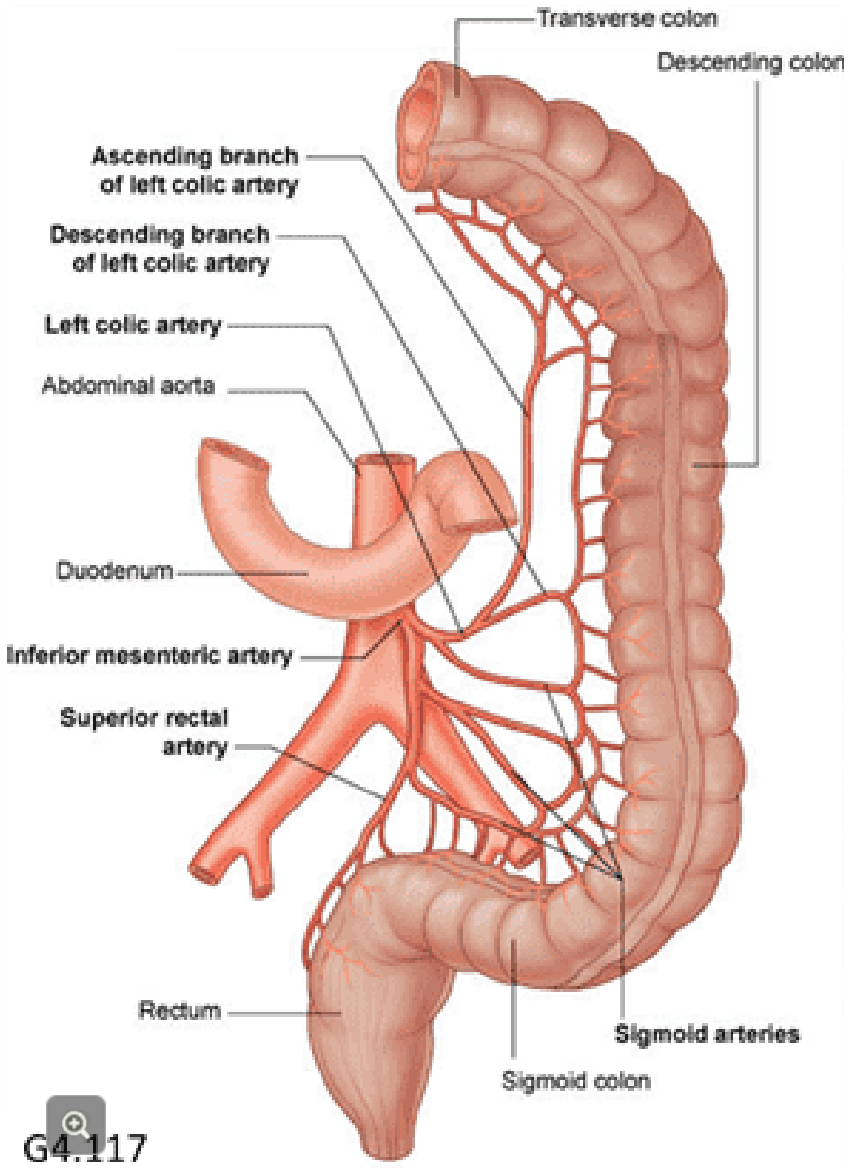
The IMA **arises from the anterior aspect of the abdominal aorta** at the level of the L3 vertebra, **posterior to the horizontal portion of the duodenum**. Its branches supply the distal (left) 1/3 of the transverse colon, the descending and sigmoid colon and the proximal rectum. The branches of the IMA are accompanied by veins which take the same name.

All branches of the IMA are retroperitoneal, except those that supply the (intraperitoneal) sigmoid colon.

The **left colic artery** supplies the descending colon. Its **ascending branch** extends toward the **left colic flexure** to supply the distal third of the transverse colon. There it **anastomoses with the SMA** via the **left branch of the middle colic artery**. The union of these vessels forms the **marginal artery** (of Drummond).

The **descending branch** of the left colic artery anastomoses with the first sigmoid artery. Three or four **sigmoid arteries** travel through the **sigmoid mesocolon** to supply the **sigmoid colon**. The sigmoid arteries form **arcades**, much like the intestinal arteries.

The terminal branch of the IMA is the **superior rectal artery**. It divides into right and left branches which pass into the pelvis on either side of the rectum.



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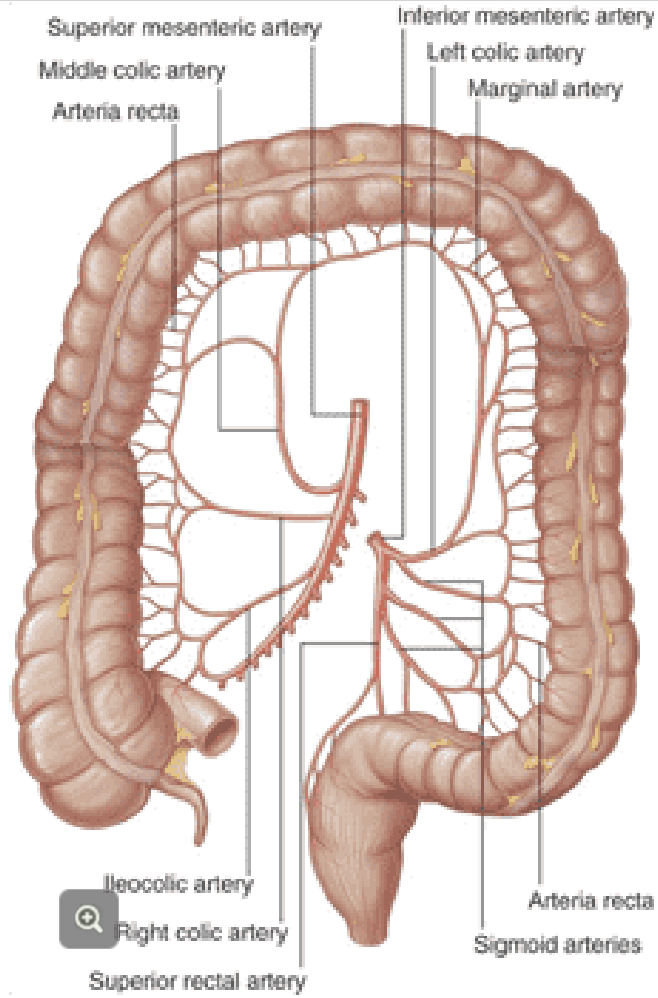


The major anastomosis between the SMA and IMA is the **marginal artery**. It joins the **middle colic artery** (SMA) with the **left colic artery** (IMA) around the **splenic flexure** of the large intestine.

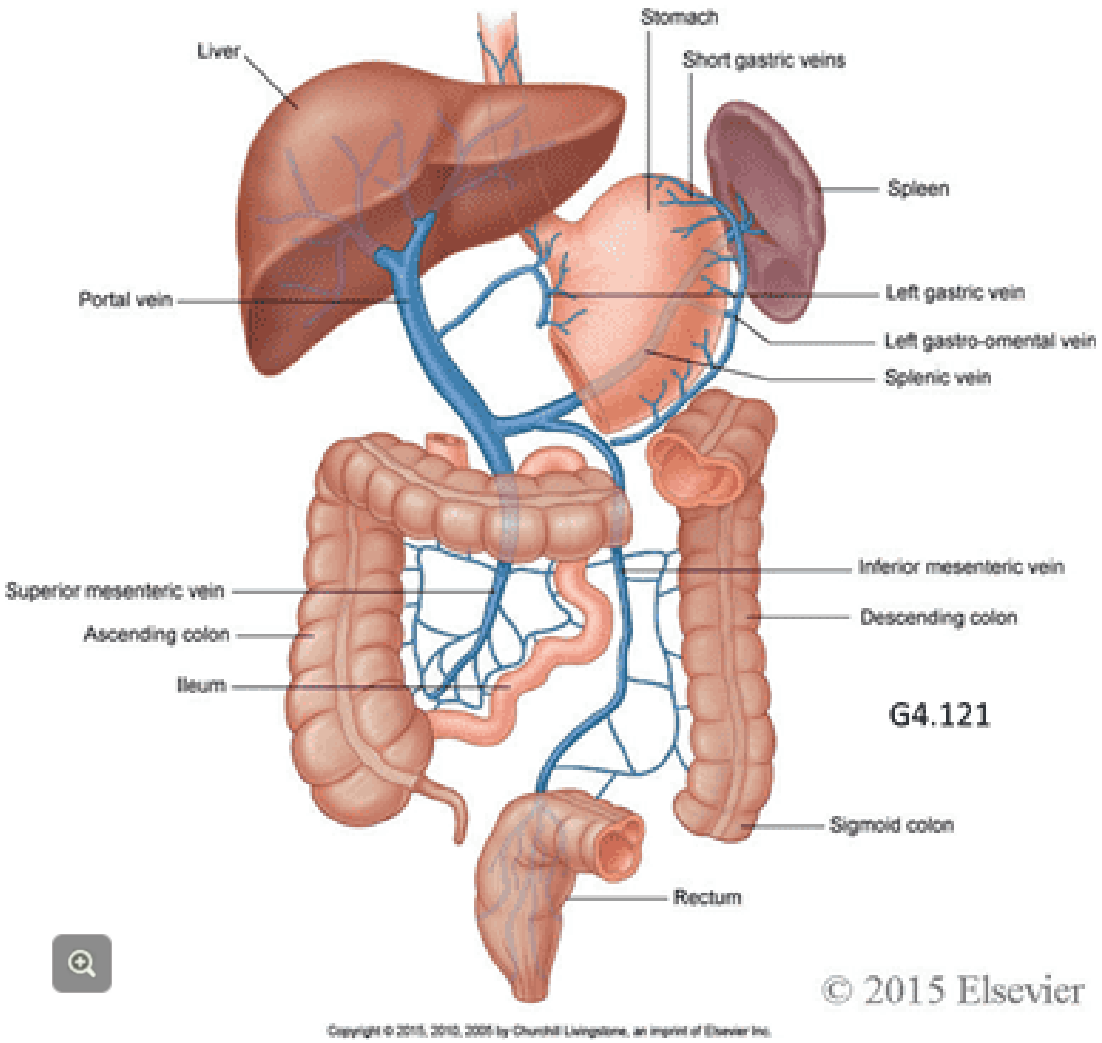
The **IMV lies to the left of** the IMA. The IMV **drains blood from the hindgut to the hepatic portal system**. The tributaries of the IMV accompany, and taking the same names as, the branches of the IMA. Thus, they are the **superior rectal, sigmoid** and **left colic veins.**

As illustrated, the IMV usually drains into the **splenic vein**, which then joins the **SMV** to form the **hepatic portal vein**.

In a common variation, the **IMV** empties into the **SMV** at the point where it joins the **splenic vein**.

Through dissection, you will see which of these variations exists in your cadaver.

Hundreds of lymph nodes occupy the field of the IMA within the retroperitoneum and the sigmoid mesocolon. The lymphatic channels that drain this field follow the branches of the IMA to the **inferior mesenteric lymph nodes** in the region of the **junction of the IMA with the abdominal aorta**.



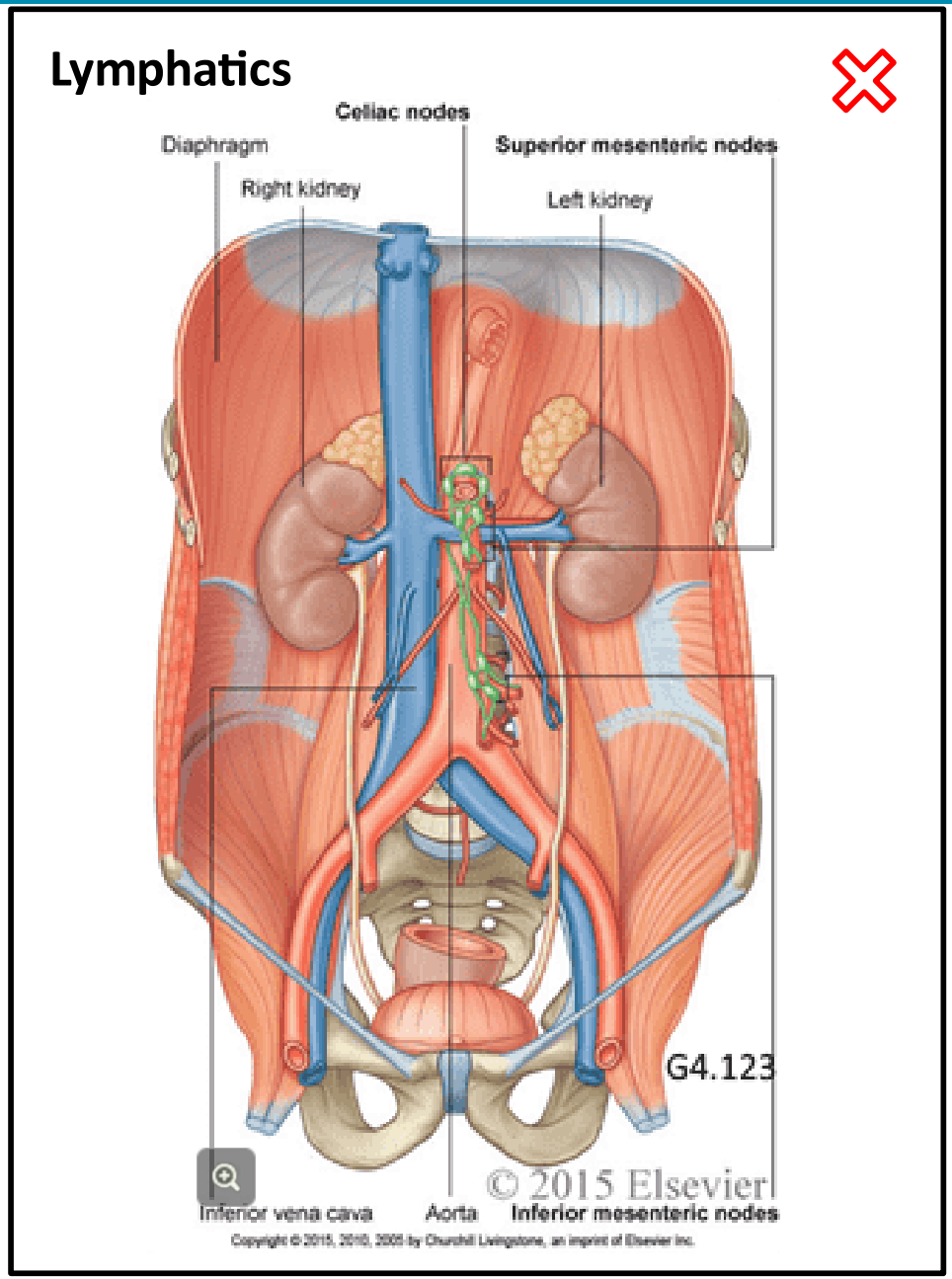
The **IMV lies to the left of** the IMA. The IMV **drains blood from the hindgut to the hepatic portal system**. The tributaries of the IMV accompany, and taking the same names as, the branches of the IMA. Thus, they are the **superior rectal, sigmoid** and **left colic veins.**

As illustrated, the IMV usually drains into the **splenic vein**, which then joins the **SMV** to form the **hepatic portal vein**.

In a common variation, the **IMV** empties into the **SMV** at the point where it joins the **splenic vein**.

Through dissection, you will see which of these variations exists in your cadaver.

Hundreds of lymph nodes occupy the field of the IMA within the retroperitoneum and the sigmoid mesocolon. The lymphatic channels that drain this field follow the branches of the IMA to the **inferior mesenteric lymph nodes** in the region of the **junction of the IMA with the abdominal aorta**.



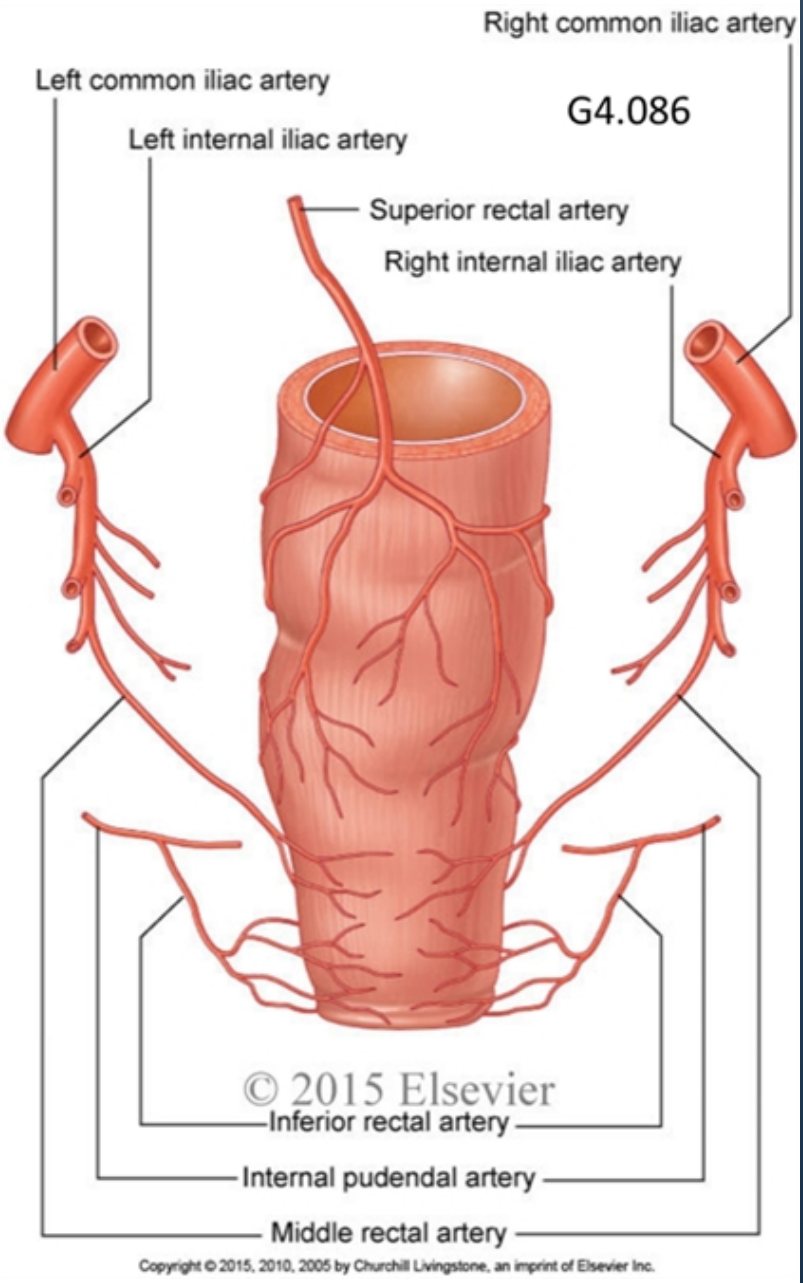
The rectum receives its blood supply from **three sources:**

- the **superior rectal artery** from the **IMA**, and
- the **middle** and **inferior rectal arteries** from the **internal iliac arteries**.

Similarly, the venous drainage from the rectum empties via:

- the **superior rectal veins** into the **IMV** and thereby into the **hepatic portal system**, and
- the **middle** and **inferior rectal veins** into the **internal iliac veins**, and thus into the **systemic (caval) system**.

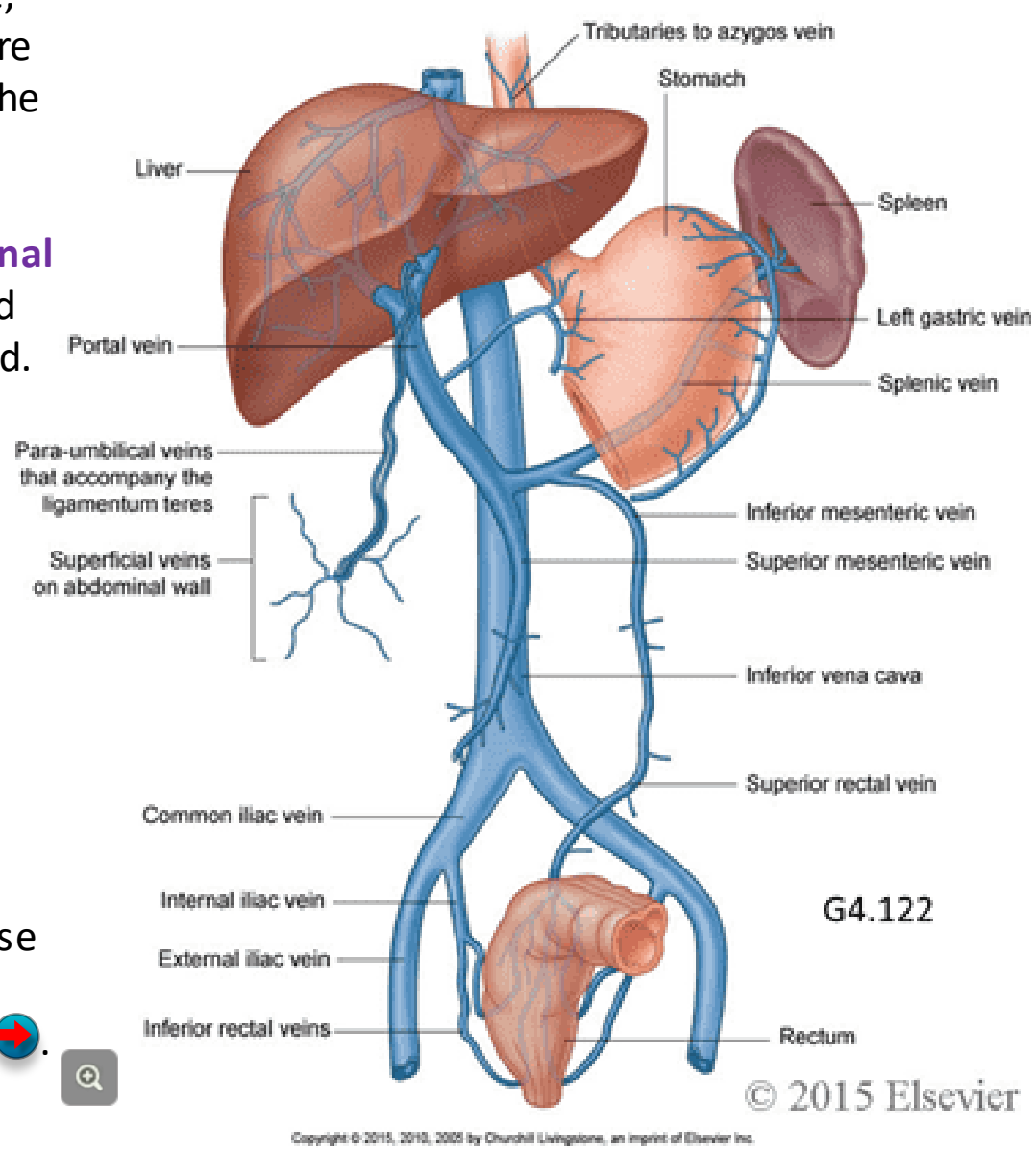
Thus, the rectal arteries and veins form an anastomosis between the portal and caval venous systems. This is an example of a **portal-caval** or **portal-systemic anastomosis**.



Portal hypertension may result from, for example, cirrhosis of the liver. With elevated venous pressure in the hepatic portal system, blood draining from the rectum can **bypass the portal system** and flow through the **middle and inferior rectal veins** into the **systemic (caval) system of veins** via the **internal iliac veins**. This can result in **rectal varices**, dilated rectal veins, with the potential to rupture and bleed.

Another point of portal-systemic anastomosis is the inferior esophagus, which drains both into the **left gastric vein** and the **azygous system** of veins. Portal hypertension can cause **esophageal varices**, which, if they rupture, can cause life-threatening hemorrhage, in the form of an **upper GI bleed**.

Lastly, the **paraumbilical veins** connect the **superficial veins of the anterior abdominal wall with the portal vein**. Portal hypertension can cause dilation of superficial abdominal veins, seen as **caput Medusae** of the anterior abdominal wall.



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Caput Medusae

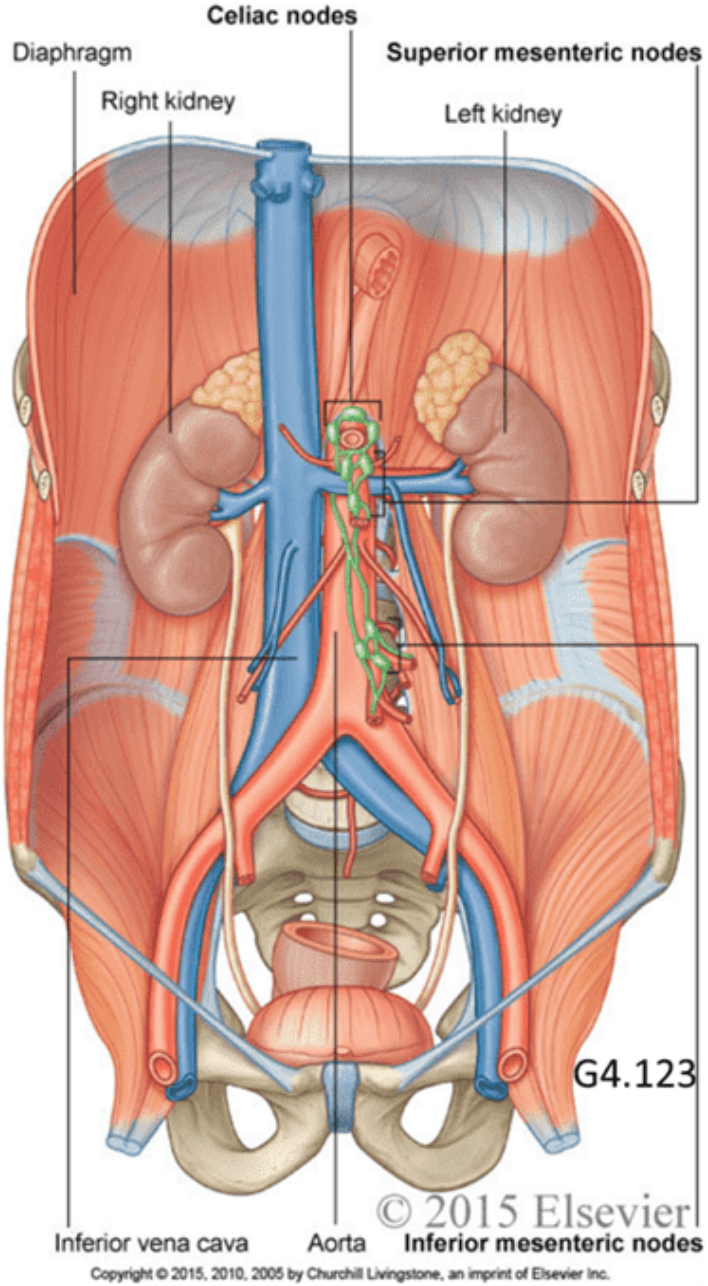
Lymph from the abdominopelvic portions of the GI tract, including the superior rectum, liver, gallbladder, pancreas and spleen, drains into the **preaortic lymph nodes**. This group includes the **celiac, superior mesenteric and inferior mesenteric groups of nodes**, named for their associations with the origins of the similarly-named arteries.

Lymph from hindgut structures drains into the **inferior mesenteric group of lymph nodes**.

Lymph from midgut structures drains into the **superior mesenteric group of lymph nodes**, which also receives lymph from the inferior mesenteric nodes.

Lymph from foregut structures drains into the **celiac group of lymph nodes**, which also receives lymph from the superior mesenteric nodes, which includes lymph from the inferior mesenteric nodes.

Lymph from the celiac lymph nodes drains, via the **intestinal trunks**, into the **cisterna chili**. From there it is conducted along the **thoracic duct** to the **left venous angle**, where it is returned to blood.



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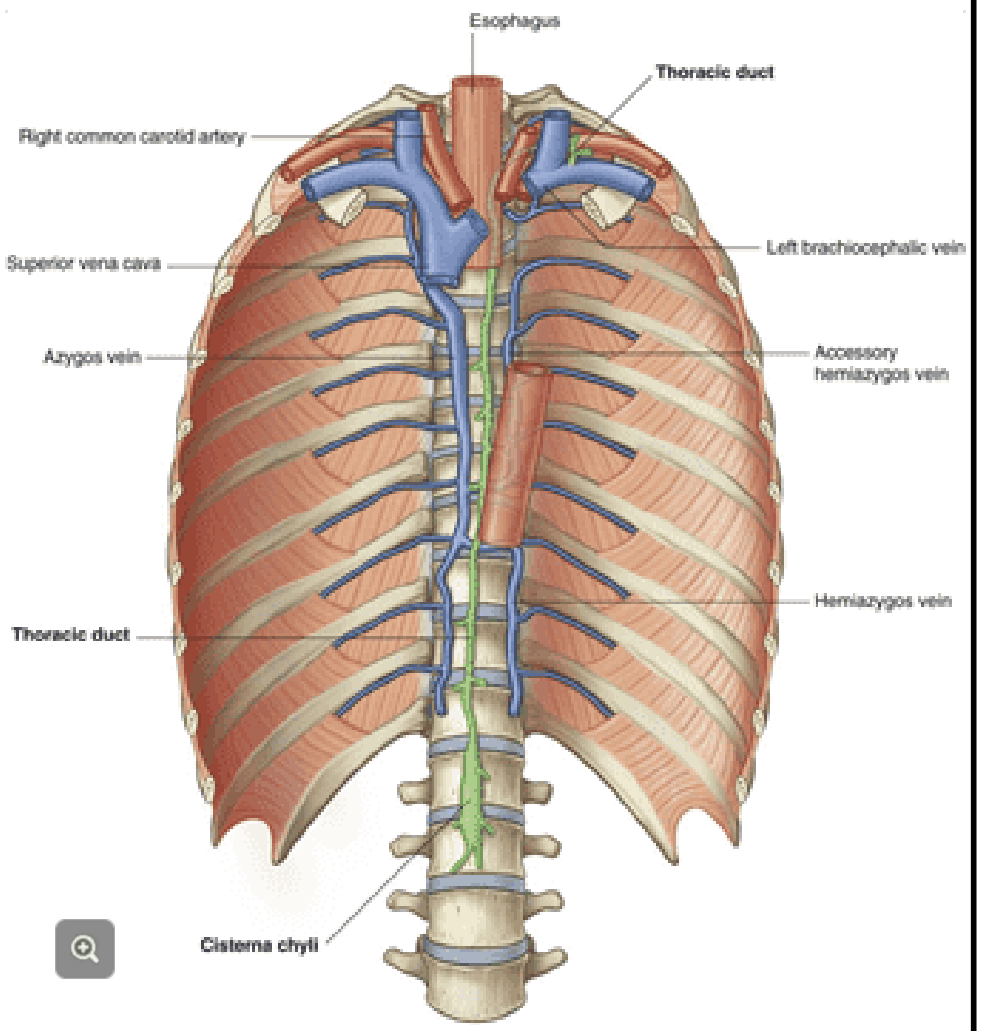
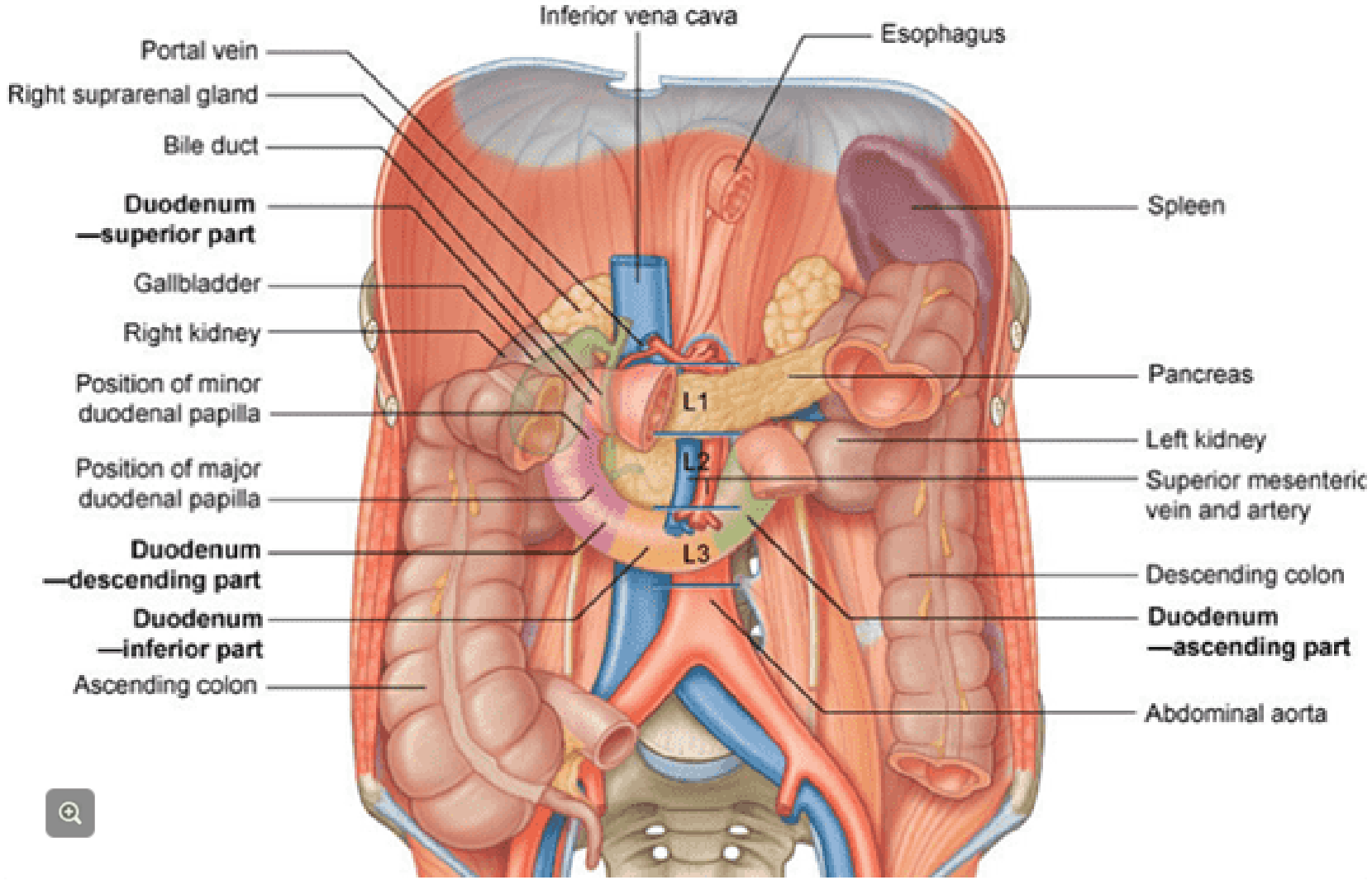
The Thoracic Duct



The Pancreatic Bed

The **duodenum and pancreas** are intimately associated with each other, both anatomically and functionally. The **duodenum receives the exocrine secretions of both the pancreas and liver** via a duct system. In the duodenum, these secretions are **mixed with chyme**, delivered from the stomach via the pyloric orifice.



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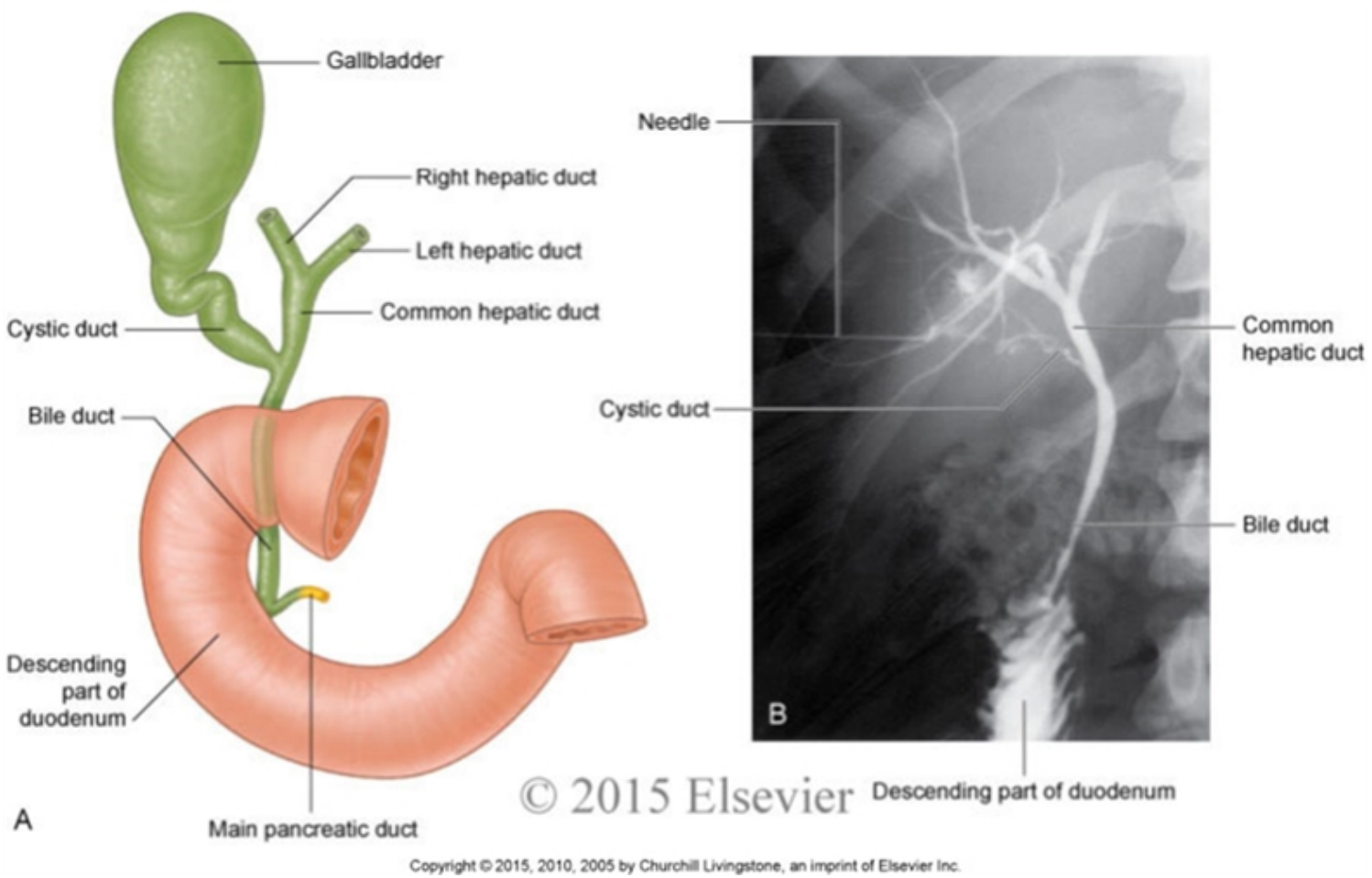
The Bile Duct System



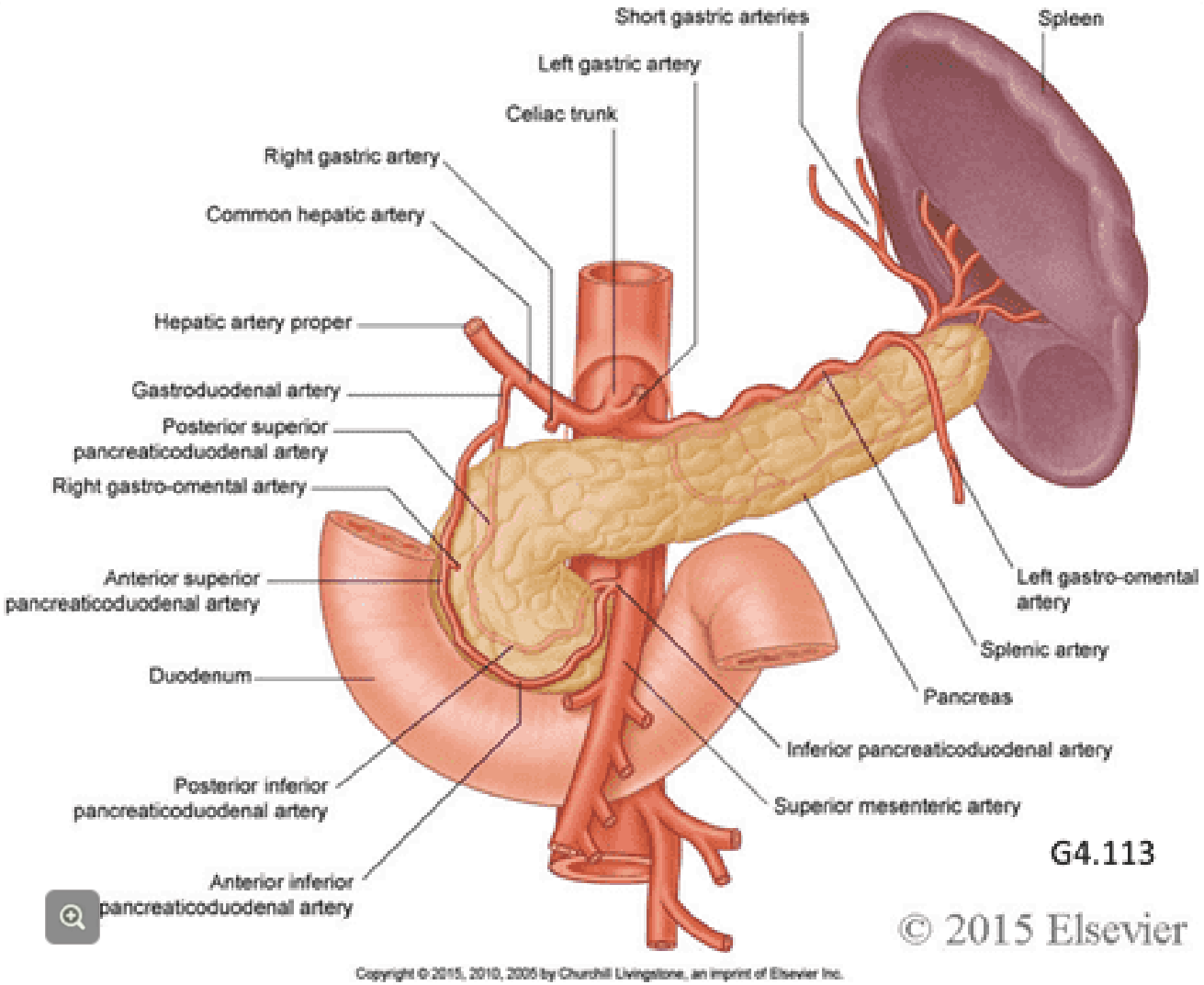
G4.102

The pancreas develops as an outgrowth of the developing duodenum at the dividing line between the foregut and the midgut. The duodenum and pancreas, therefore, receive their blood supply from **superior and inferior pancreaticoduodenal arteries**, which arise from branches of the **celiac trunk** and **superior mesenteric arteries**, respectively.

Locate the pancreas and duodenum in this diagram:

Notice that they are both **retroperitoneal**, located posterior to the stomach and lesser sac (omental bursa).

They are embedded in loose CT and adipose, and only their **anterior surfaces**, which are exposed to the lesser sac, **are covered with visceral peritoneum**.



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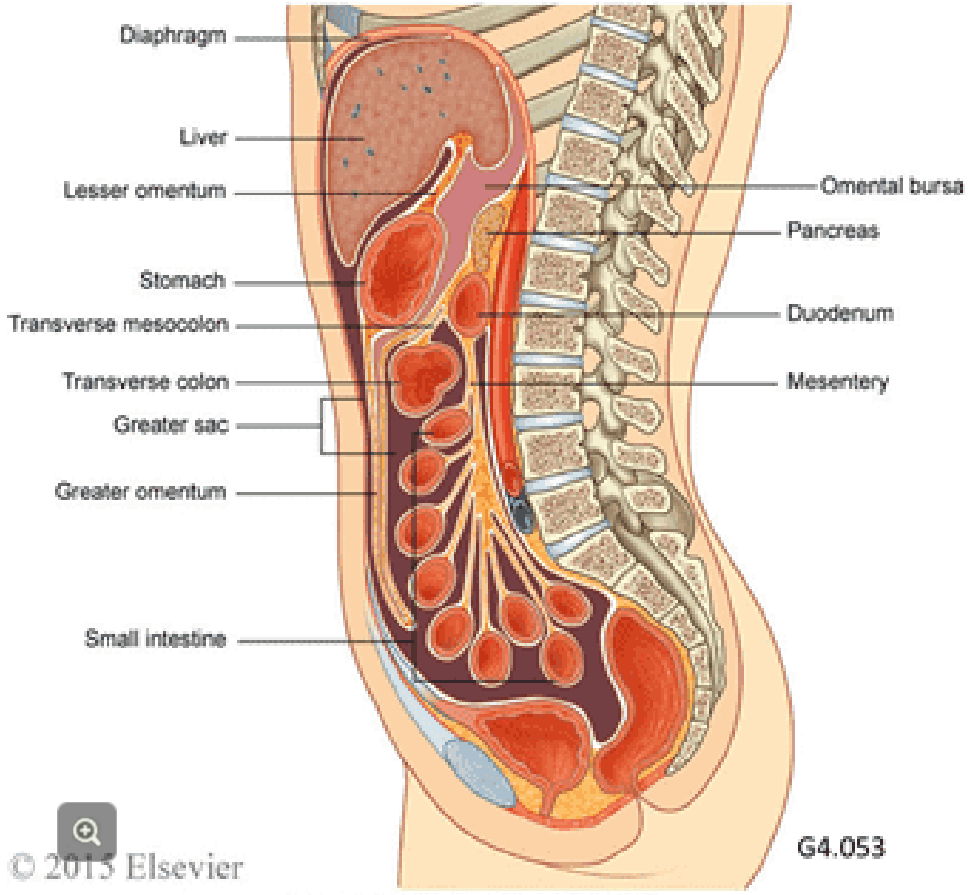
The Pancreas and Duodenum are Secondarily Retroperitoneal



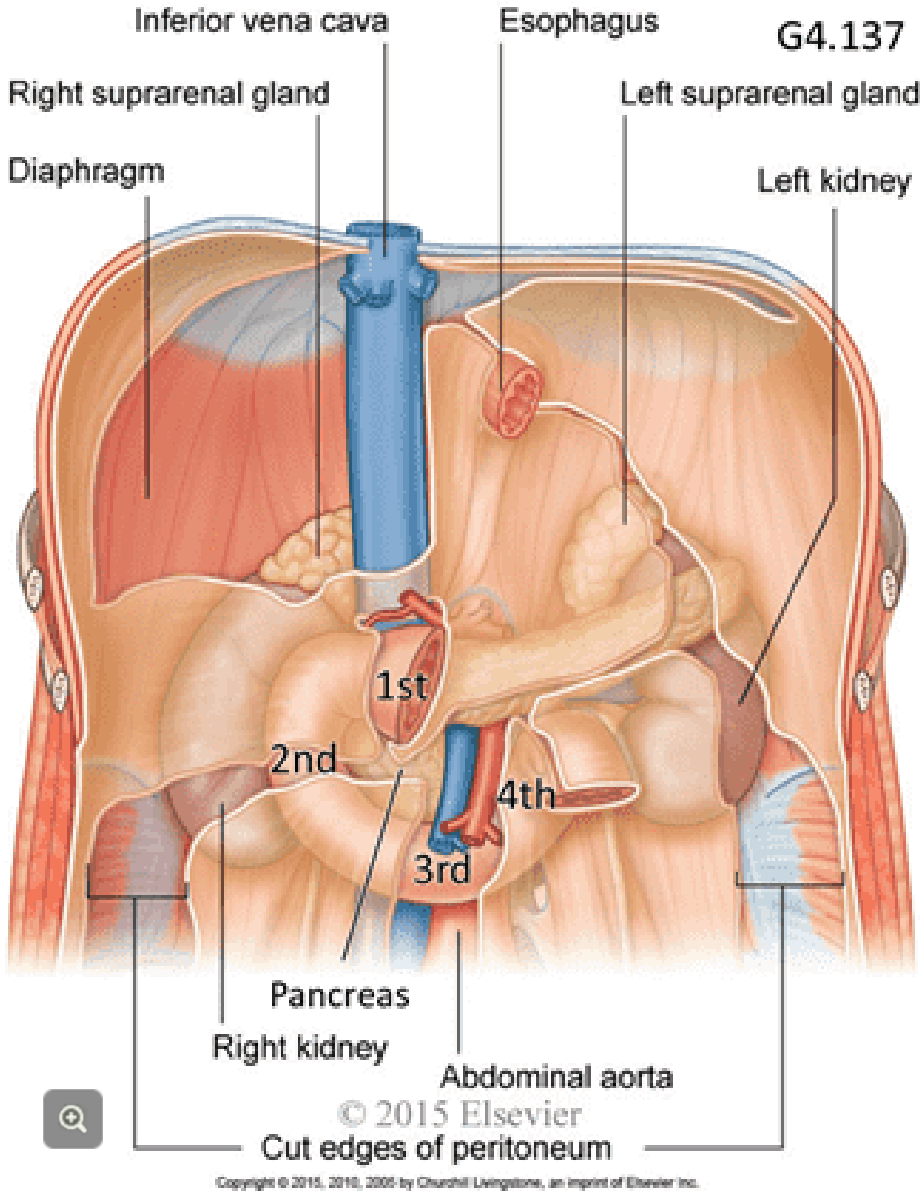
The duodenum, you'll recall, is divided into **four parts**: the 1st (superior), the 2nd (descending), the 3rd (horizontal) and the 4th (ascending) parts.

The proximal 2 cm of the 1st part of the duodenum **is intraperitoneal**, and occupies the **hepatoduodenal ligament**. **The remainder** of the duodenum is **secondarily retroperitoneal**.

The **pancreas** is 15 cm long, and is shaped like the letter "J". The hook of the J **wraps around the back of the superior mesenteric artery and vein**. The pancreas extends from the duodenum, on the right, to the hilum of the spleen, on the left.

The **pancreas** is described as having:

- a **head**, cradled in the curve of the duodenum,
- a **neck**, lying in front of the superior mesenteric artery and vein,
- an elongated and tapering **body**,
- a **tail**, which occupies the **splenorenal ligament** and ends at the hilum of the spleen, and
- an **uncinate process**, which extends from the head of the pancreas to wrap behind the superior mesenteric artery and vein.



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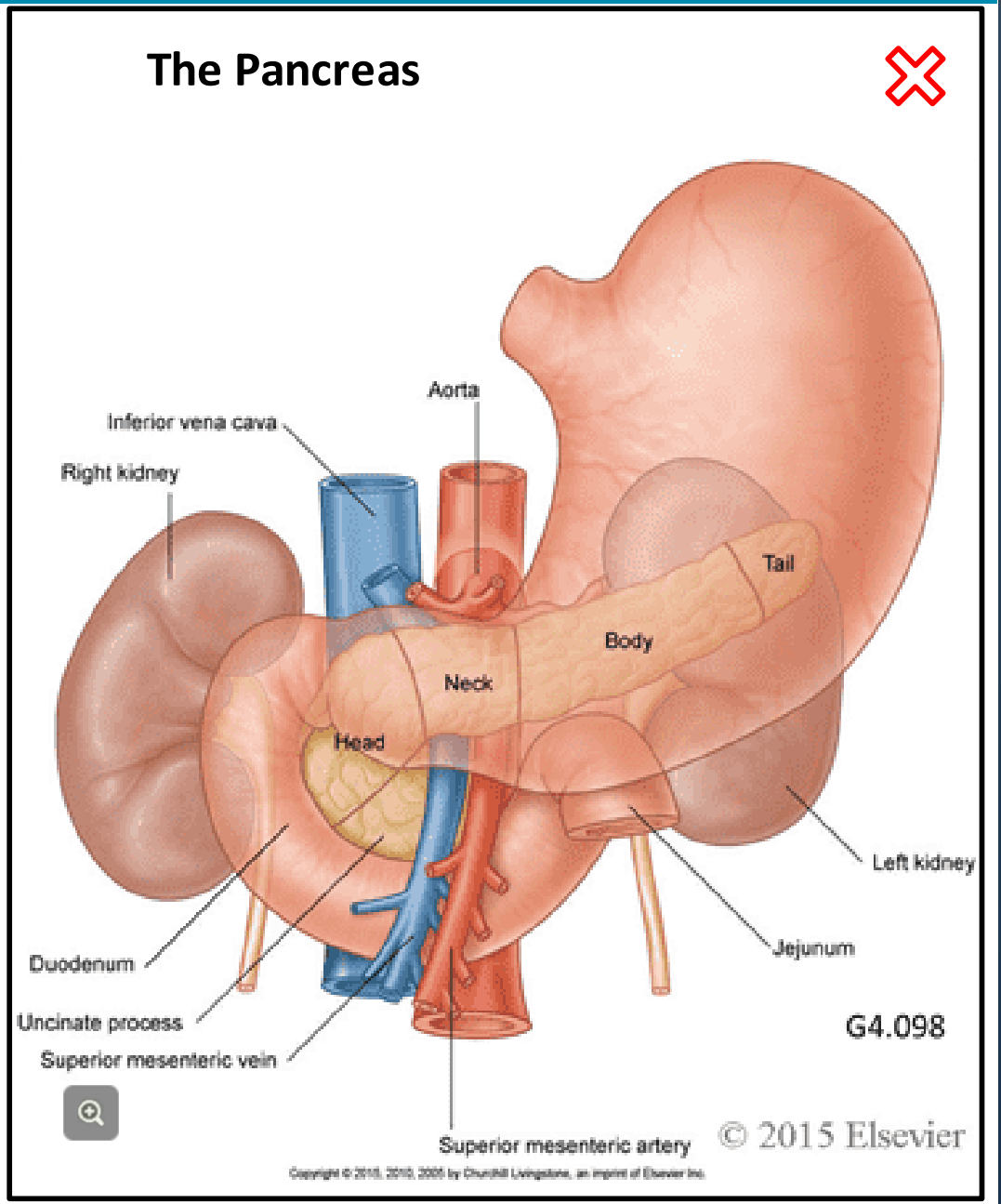


12.1 The Midgut, Hindgut and Pancreatic Bed

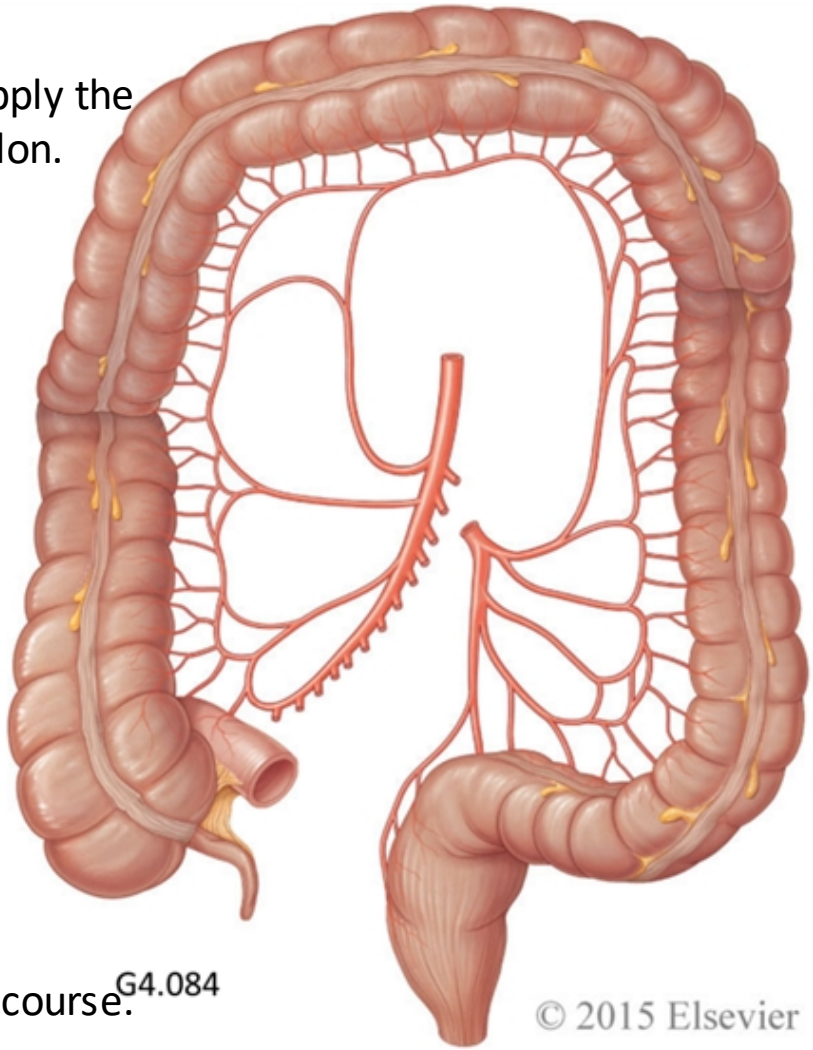
What you'll need:

SPECIMENS

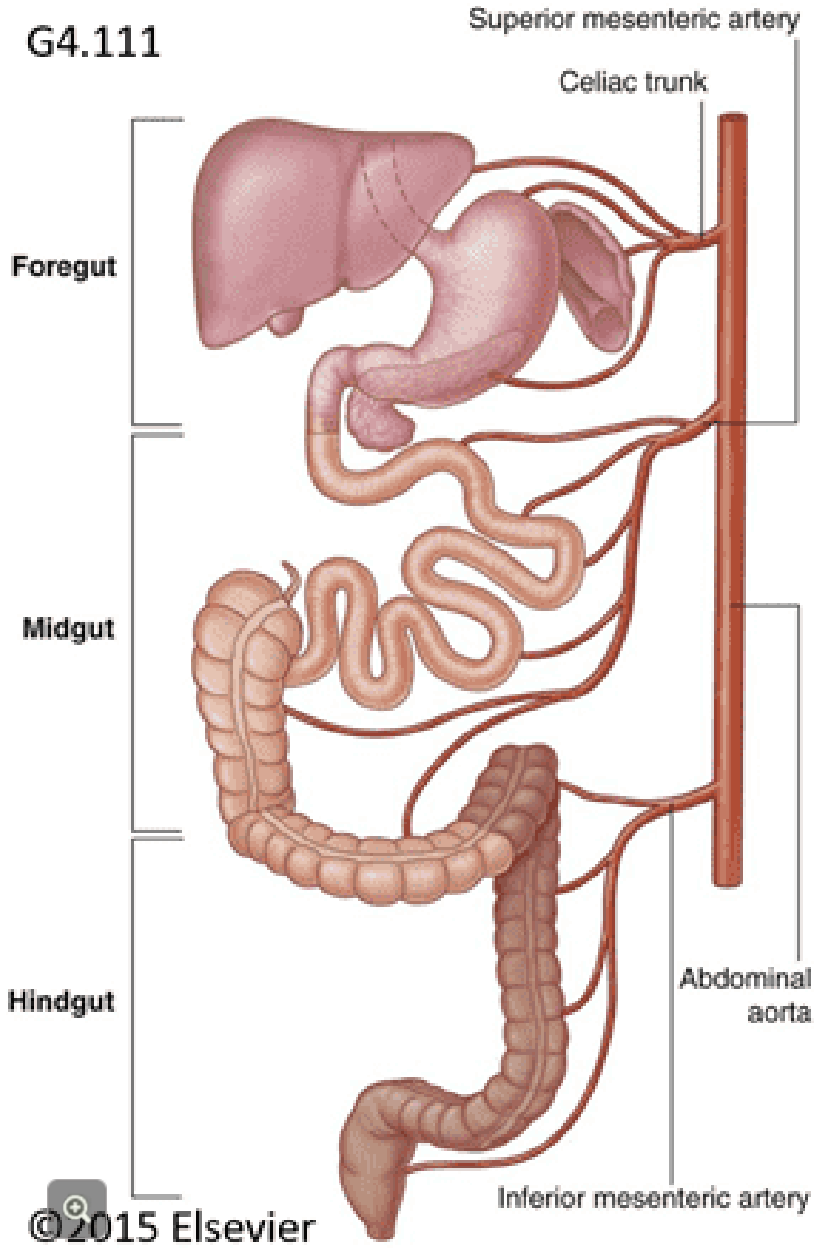
- Cadavers 1 & 2

When you have completed this dissection, you will be able to identify and / or describe the:

- the gross features of the jejunum, ileum and large intestine.
- the mesentery of the small intestine, the transverse mesocolon and the sigmoid mesocolon and the structures contained therein.
- the superior mesenteric artery (SMA) and its branches that supply the jejunum, ileum cecum, appendix, ascending and transverse colon.
- the inferior mesenteric artery (IMA) and its branches that supply the descending and sigmoid colon, and the rectum.
- the anastomosis between the midgut and hindgut.
- the hepatic portal vein and its tributaries.
- the lymphatic drainage of the midgut and hindgut
- the parts of the duodenum, their location, relationships and course.
- the parts of the pancreas, their location, relationships and course.
- the pancreatic and bile duct systems.
- the blood supply to the duodenum and pancreas.
- the formation of the hepatic portal vein, its relationships and course.



G4.084



The digestive tract is a single (albeit convoluted) tube that has **three subdivisions: the foregut, midgut and hindgut**. It receives its blood supply from **three, unpaired, visceral branches of the abdominal aorta**. The **foregut** receives its blood supply from the **celiac trunk**, the **midgut** from the **superior mesenteric artery** and the **hindgut** from the **inferior mesenteric artery**.

These vessels arise from the aorta in the posterior body wall. In order for their branches to gain access to intraperitoneal organs, they must pass through **mesenteries** or **ligaments**, the latter being structures analogous to mesenteries, but smaller. Like mesenteries, ligaments **consist of two layers of serous membrane with loose CT, adipose, Ns, BVs and Ls sandwiched between them**.

The focus of this dissection is the midgut and hindgut. You will dissect the branches of the superior and inferior mesenteric arteries that supply the distal duodenum and a portion of the pancreas, the jejunum, ileum, cecum, colon and rectum.

TASK

OPEN the body bag and reflect the abdominal skin flaps.

Reflect the greater omentum superiorly, over the costal margin to reveal the midgut and hindgut in the infracolic compartment.

Before dissecting, you will get your bearings by identifying the structures that comprise the midgut and hindgut.

The jejunum and ileum comprise the portion of the small intestine distal to the duodenum, the jejunum being the proximal 2/5 and the ileum the distal 3/5. The duodenojejunal junction is abrupt: **the jejunum begins where the duodenum leaves the retroperitoneum to acquire a mesentery**. In contrast, the transition from jejunum to ileum is gradual, and is based on both histology and gross anatomy.

TASK

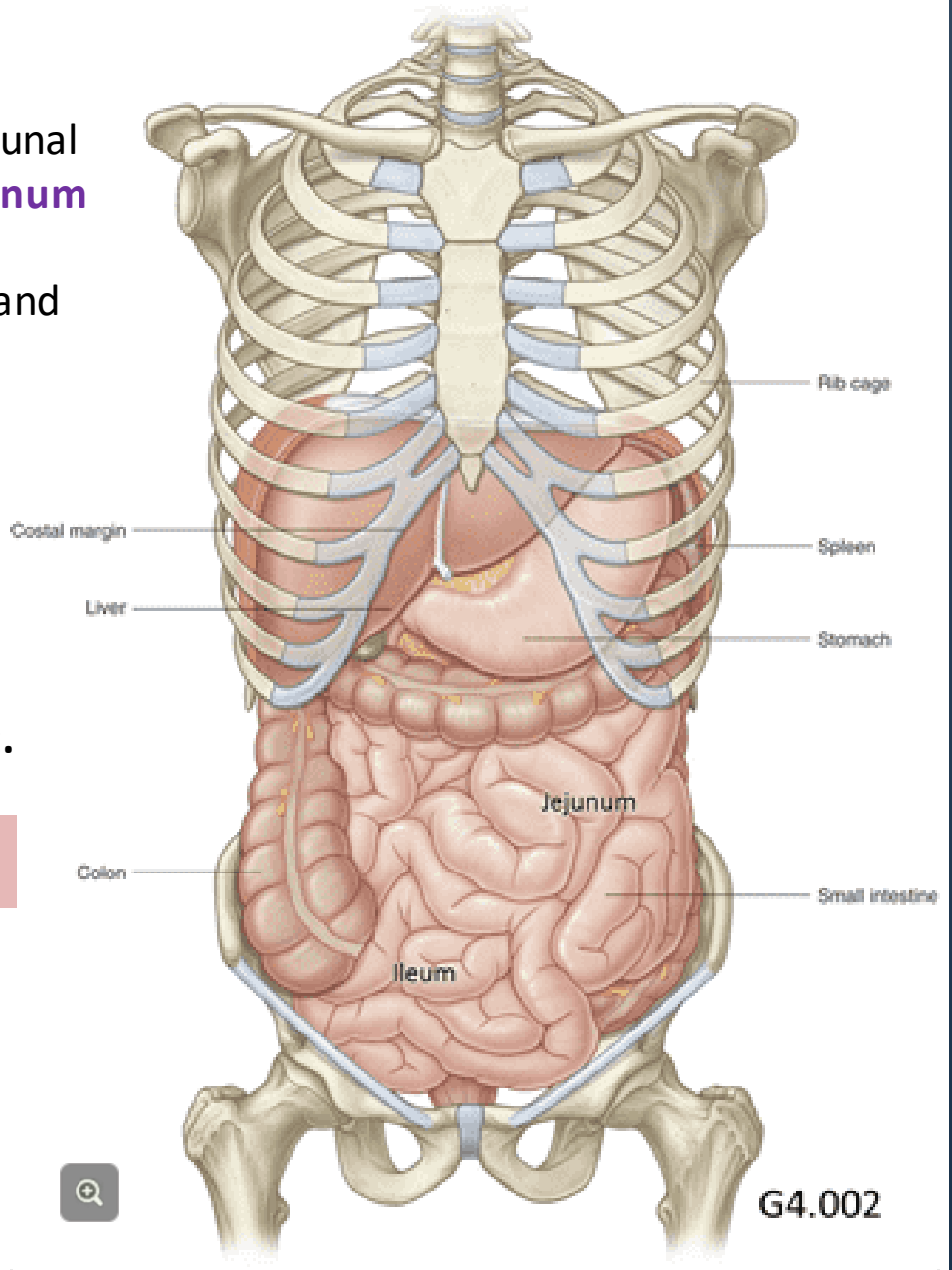
In the cadaver,

note the loops of small bowel occupying most of the infracolic compartment. Identify, in general, the jejunum in the upper left portion of the infracolic compartment, and the ileum in the lower right portion of the infracolic compartment.

TASK

FOLLOW the jejunum proximally to where

it begins as the small intestine acquires a mesentery to becomes intraperitoneal. This is the duodenal-jejunal junction. Follow the ileum to its terminus at the ileocecal junction. Identify the ileocecal valve by feeling its greater thickness, as compared to the wall of the ileum or cecum.



The large intestine is 1.5 m long and extends from the cecum to the anus. It functions to absorb water and salt from the luminal contents to form feces. It includes the cecum, appendix, colon, rectum and anal canal.

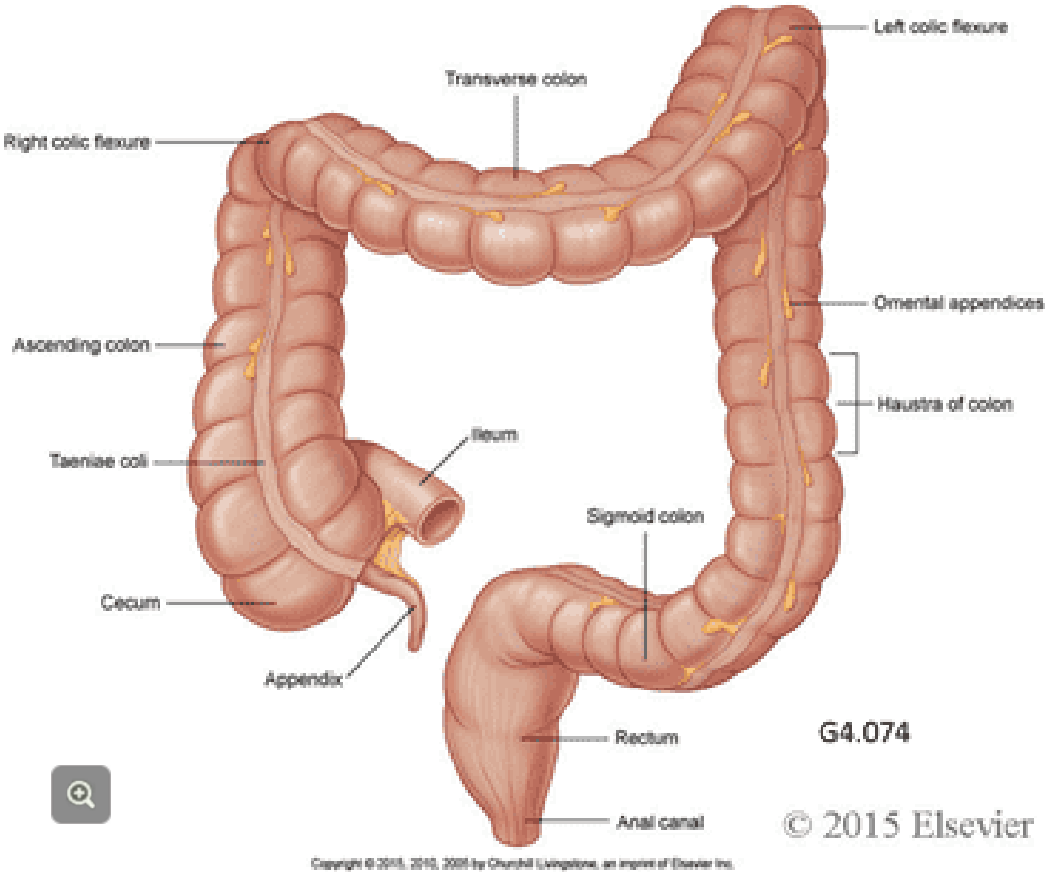
TASK

IDENTIFY the cecum, ascending, transverse, descending and sigmoid colon.

Identify the right colic flexure (hepatic flexure) and the left colic flexure (splenic flexure). Notice that the ascending and descending colon, being secondarily retroperitoneal, are fixed to the posterior abdominal wall. Identify the spaces lateral to both the ascending and descending colon, the right and left paracolic gutters. Fluid may accumulate in these spaces in a supine individual, and channel though these spaces with upright posture. **Identify the transverse mesocolon and sigmoid mesocolon.**

Next, identify the features that distinguish the colon from the small intestine:

1. **its larger diameter;**
2. **epiploic (omental) appendages, tags attached to the colon composed of fat enclosed in peritoneum;**
3. **teniae coli, three longitudinal strips of smooth muscle that comprise the outer layer of its muscularis externa;**
4. **haustra, the sacculations of the large bowel formed by contraction of the teniae coli.**



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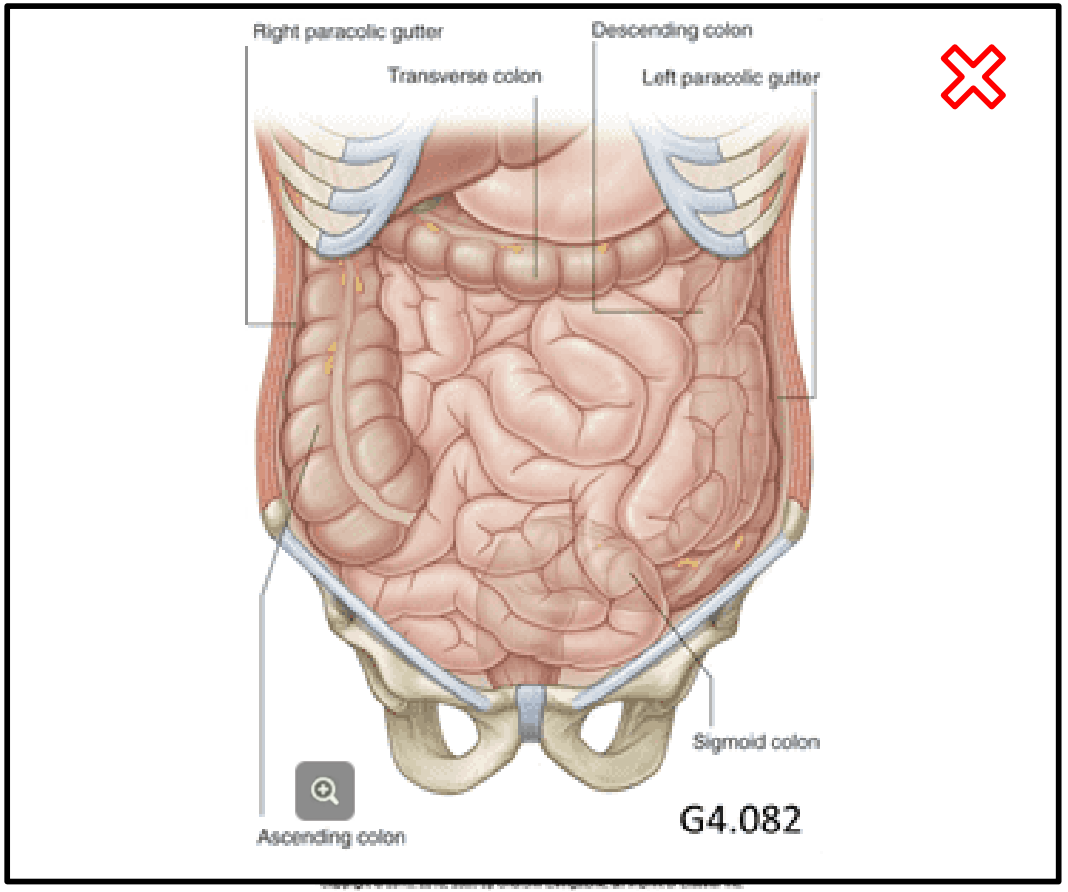

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4. **haustra, the sacculations of the large bowel formed by contraction of the teniae coli.**

TASK

IDENTIFY the cecum.

It is that portion of the colon inferior to the ileocecal junction. Note its location; it is usually located in the right iliac fossa, although it may cross the pelvic brim and lie in the true pelvis.

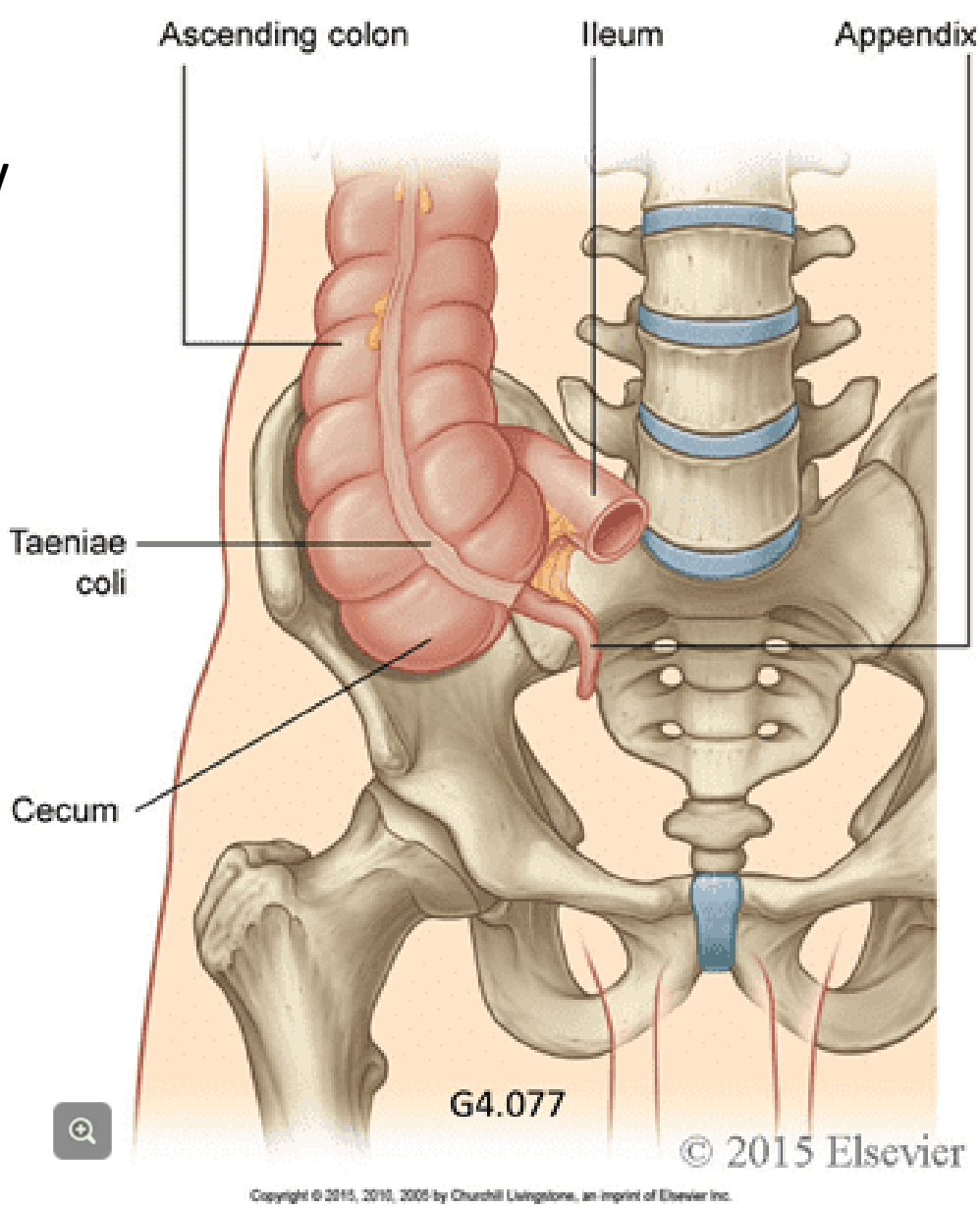
TASK

IDENTIFY the appendix.

Locate it where it attaches to the posteromedial aspect of the cecum, inferior to the ileocecal junction, at the base of a tenia coli.

While its point of attachment is circumscribed, the location of the appendix itself is variable. It is **retrocecal** in almost 2/3 of people and **pelvic** in most of the remaining 1/3 .

Once you have located the appendix, locate the mesoappendix, which attaches it to the terminal ileum. It contains the appendicular vessels.



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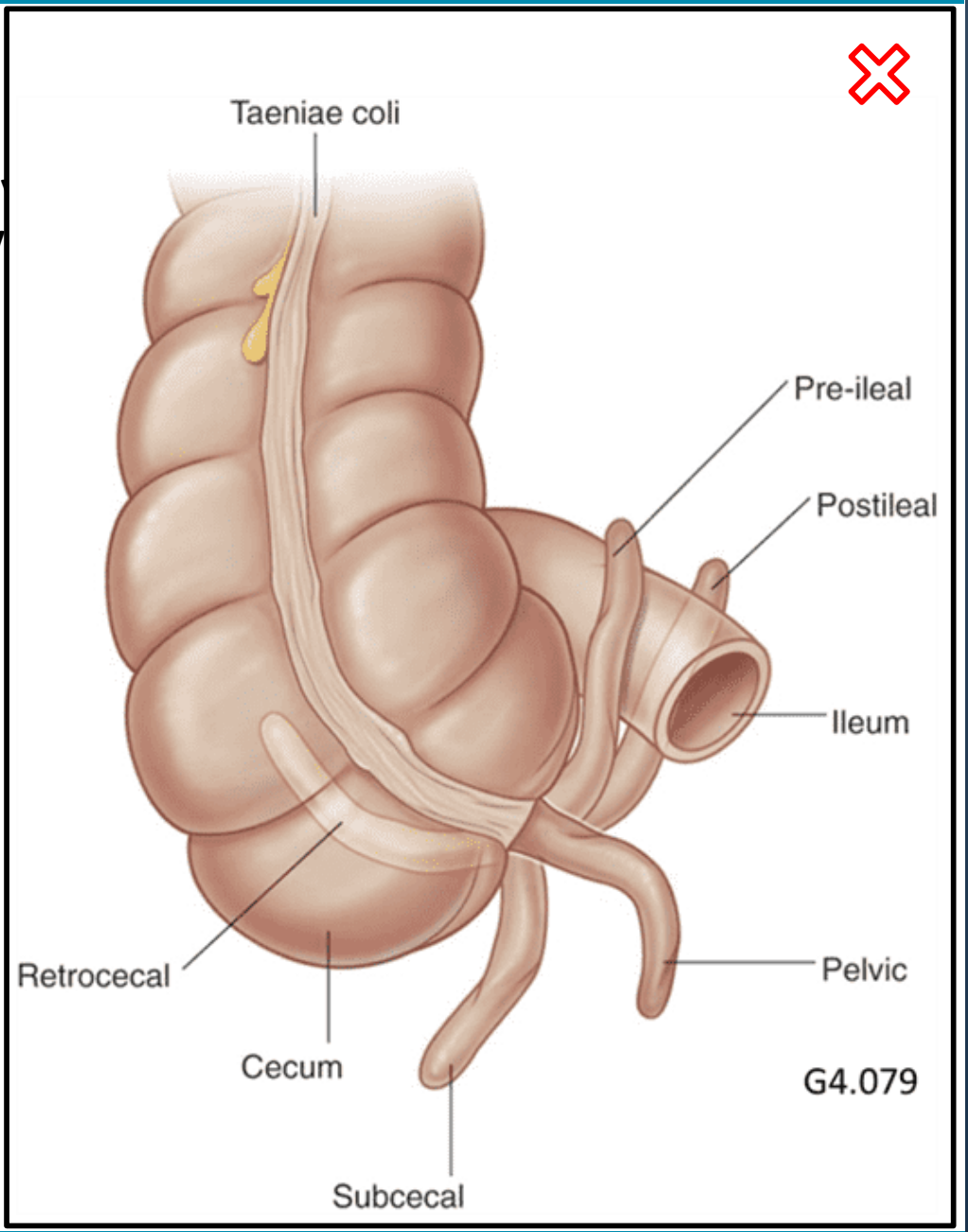
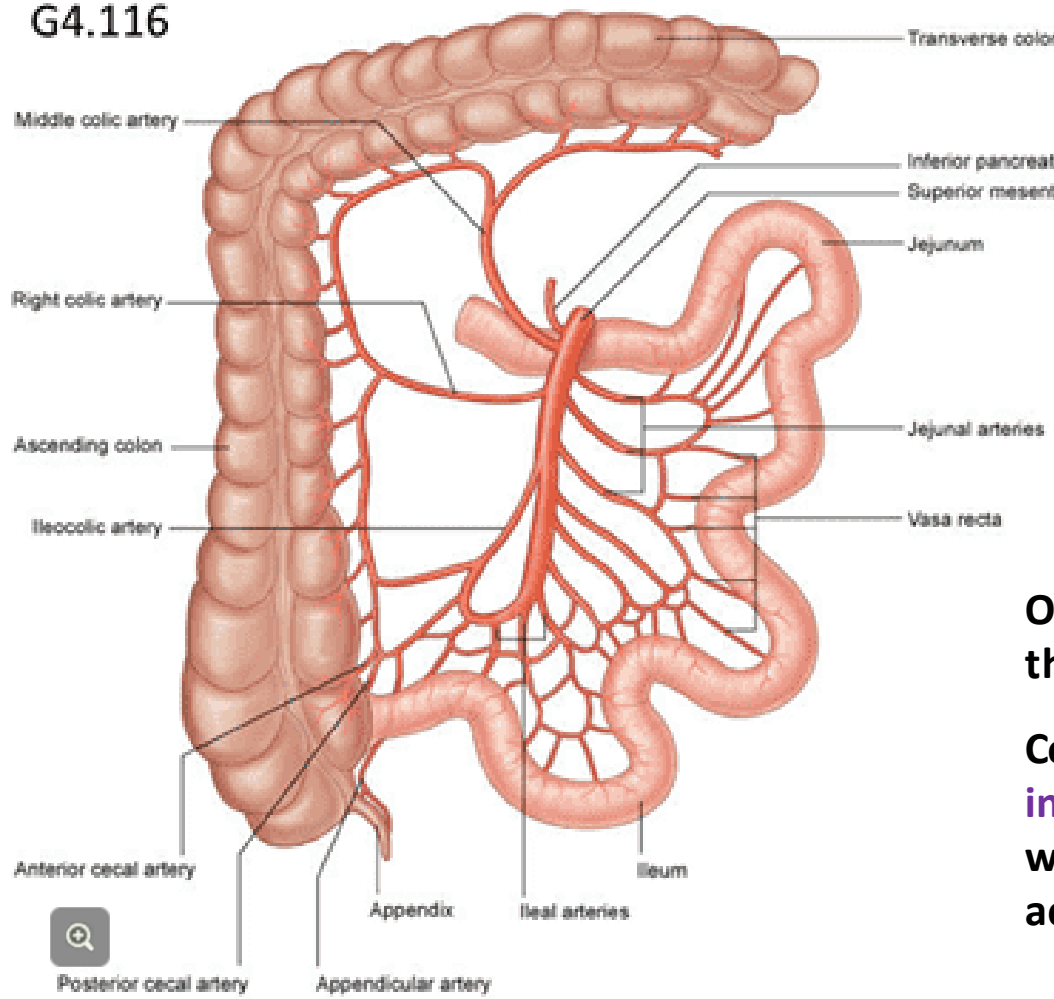


The SMA arises from the anterior aspect of the abdominal aorta at the level of the L1 vertebra, **1 cm below the origin of the celiac trunk**. The **first branch of the SMA** arises retroperitoneally to supply a portion of the **pancreas** and the **distal duodenum**. The SMA then passes anterior to the third (horizontal) part of the duodenum and left renal vein to **enter the mesentery**.

G4.116



TASK

In the accompanying diagram,

note the (retroperitoneal) course of the SMA over the horizontal portion of the duodenum.

Observe that once the SMA enters the mesentery, the jejunal and ileal arteries arise from its left side.

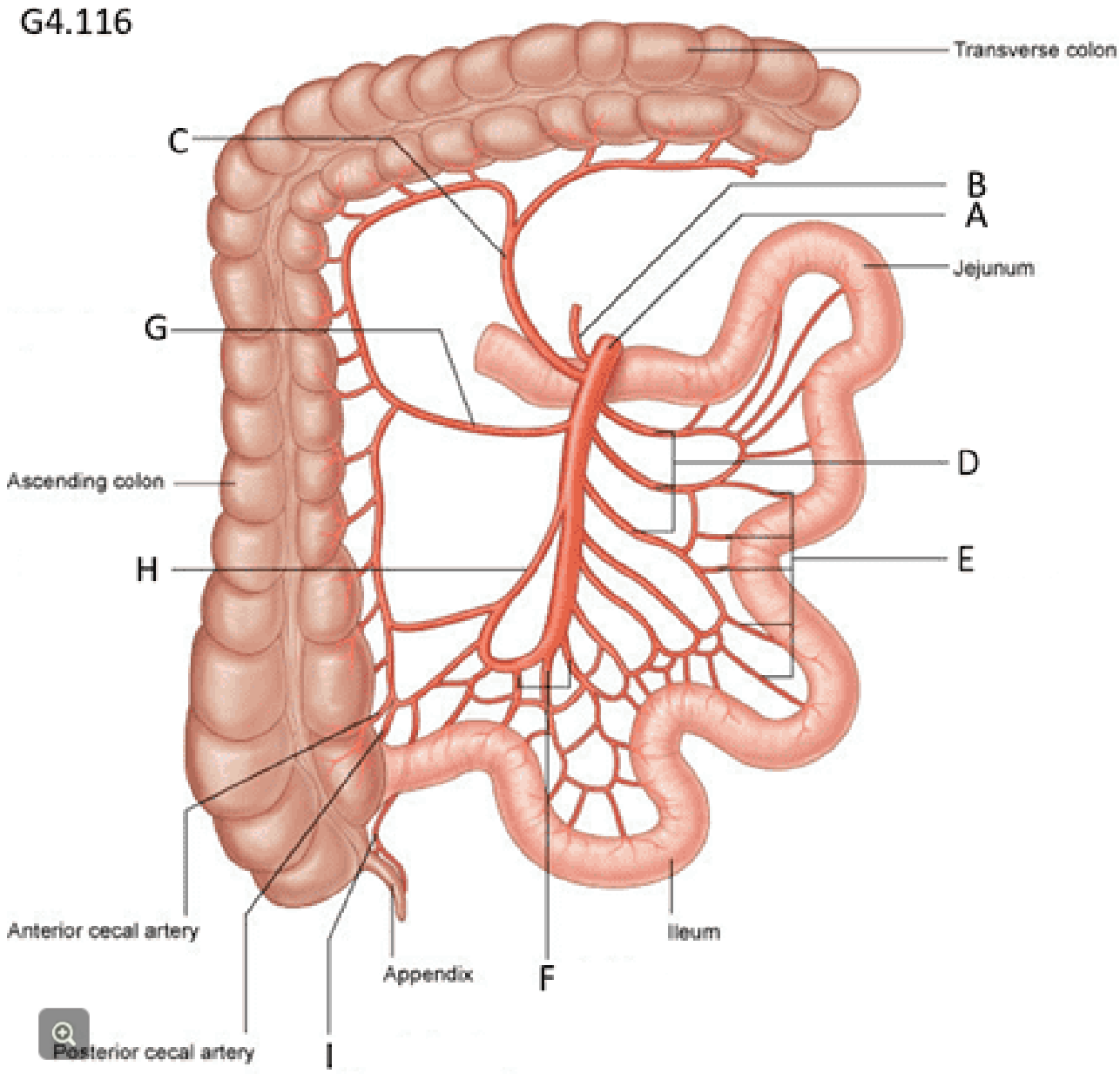
Contrast this with its branches to the large intestine (ileocolic, right colic and middle colic As), which arise from its right side. These arteries are accompanied by veins that take the same name.

In order to complete a dissection successfully, it is critical to know the anatomy of the region **prior to** taking your instruments to the cadaver.

If you feel you are ready to proceed, **quiz each other thoroughly** on the preceding foundational content by asking each other the following questions. Once you are confident in the answers, move on to the next slide and the dissection.

- What is meant by the term, "infracolic compartment"?
- What gross anatomical features distinguish the small intestine from the large intestine? Compare their overall diameters. Identify the teniae coli, epiploic appendices and haustra.
- Can you identify the right and left paracolic gutters?
- Can you identify the appendix and mesoappendix? Describe the position of the appendix in the majority of people and its position in most of the remainder of people?
- What branches, in general, arise from the left side of the SMA? What branches, in general, arise from the right side of the SMA?
- Take turns asking each other to identify the branches of the SMA using this diagram: . **Be able to state whether each artery is retroperitoneal or intraperitoneal. If it is intraperitoneal, be able to name the ligament or mesentery that contains the artery.**

11.1 The Superior Mesenteric Artery and Branches



TASK

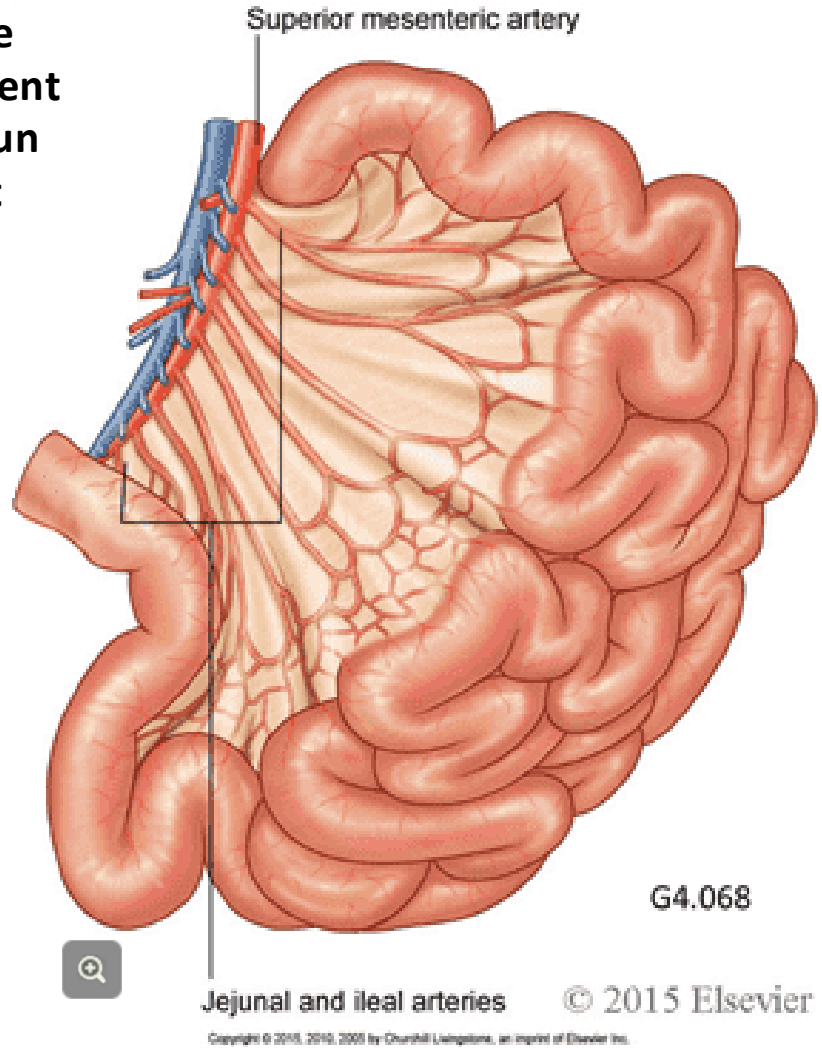
NOTE that with the greater omentum reflected

superiorly over the costal margin, the posterior surface of the transverse colon is facing anteriorly. Gently push the small intestine to the left side of the infacolic compartment so that the right side of the mesentery is facing anteriorly. Run your finger along the root of the mesentery, and note that it passes along a 15 cm-long oblique line from the upper left to the lower right quadrants, roughly from the duodenojejunal junction to the ileocecal junction. Now, realize that at its attachment to the jejunum and ileum, the mesentery is over 6 m long. As described in the prelab SLM, the mesentery is thus arranged like an elaborate folding fan.

TASK

The SMA and SMV themselves run along the

root of the mesentery. Feel within the mesentery for a larger branch the SMA and/or SMV. Use a blunt probe or forceps to tear a hole in the peritoneum overlying the vessels. Peel it back to reveal a few of the intestinal vessels extending to the left, within the mesentery. Now peel back parietal peritoneum between the root of the mesentery and the ascending colon to reveal colic branches extending to the right.



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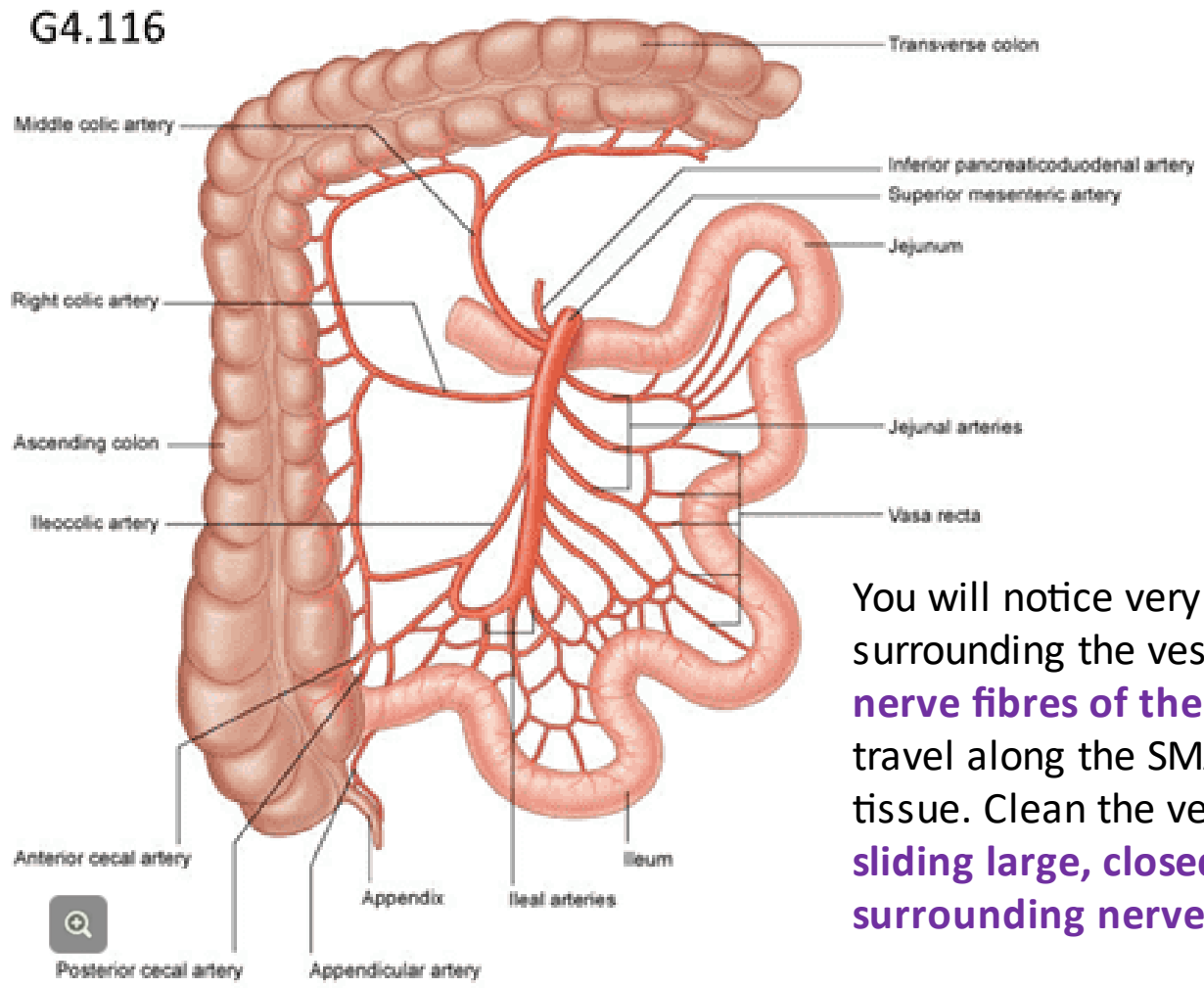
TASK

WITH the parietal peritoneum removed between the root of the mesentery and the ascending colon, and with a window opened within the mesentery itself, identify the SMA and SMV. The SMA will be to the left of the SMV, like the aorta is to the left of the IVC.



Thoroughly clean the entire length of the SMA and SMV using blunt dissection techniques. Clean them proximally under the line of attachment of the transverse mesocolon, anterior to the horizontal portion of the duodenum.

You will notice very dense, tough "connective tissue" surrounding the vessels. This is, in fact, **the autonomic nerve fibres of the of the superior mesenteric plexus** which travel along the SMA and its branches to reach their target tissue. Clean the vessels thoroughly of these nerve fibres by **sliding large, closed scissors between the vessel and surrounding nerves, and then opening the scissors**.

15 to 18 jejunal and ileal arteries arise from the left side of the SMA to form intestinal **arcades**. These arching vessels form a network within the mesentery from which **vasa recta** arise to supply the intestine.

TASK

FOCUSING on an initial portion of the jejunum,

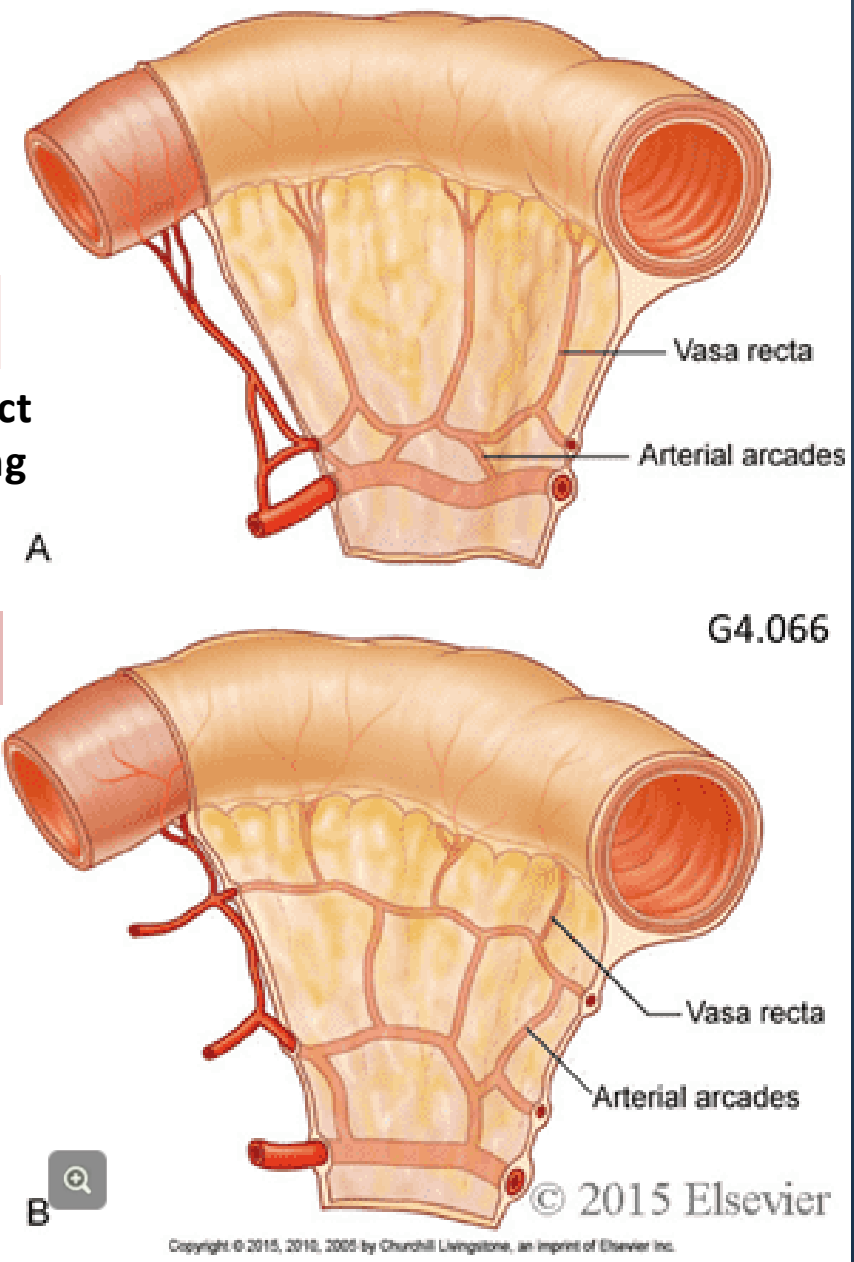
close to the duodenojejunal junction, thoroughly dissect both laminae of a short length the mesentery, removing all intervening tissue. This will reveal the characteristic architecture of the jejunal vessels (A).

TASK

NOW focusing on a distal portion of the ileum,

close to the ileocecal junction. Again, thoroughly remove both laminae of a short length the mesentery and all intervening tissue. This will reveal the characteristic architecture of the ileal vessels (B).

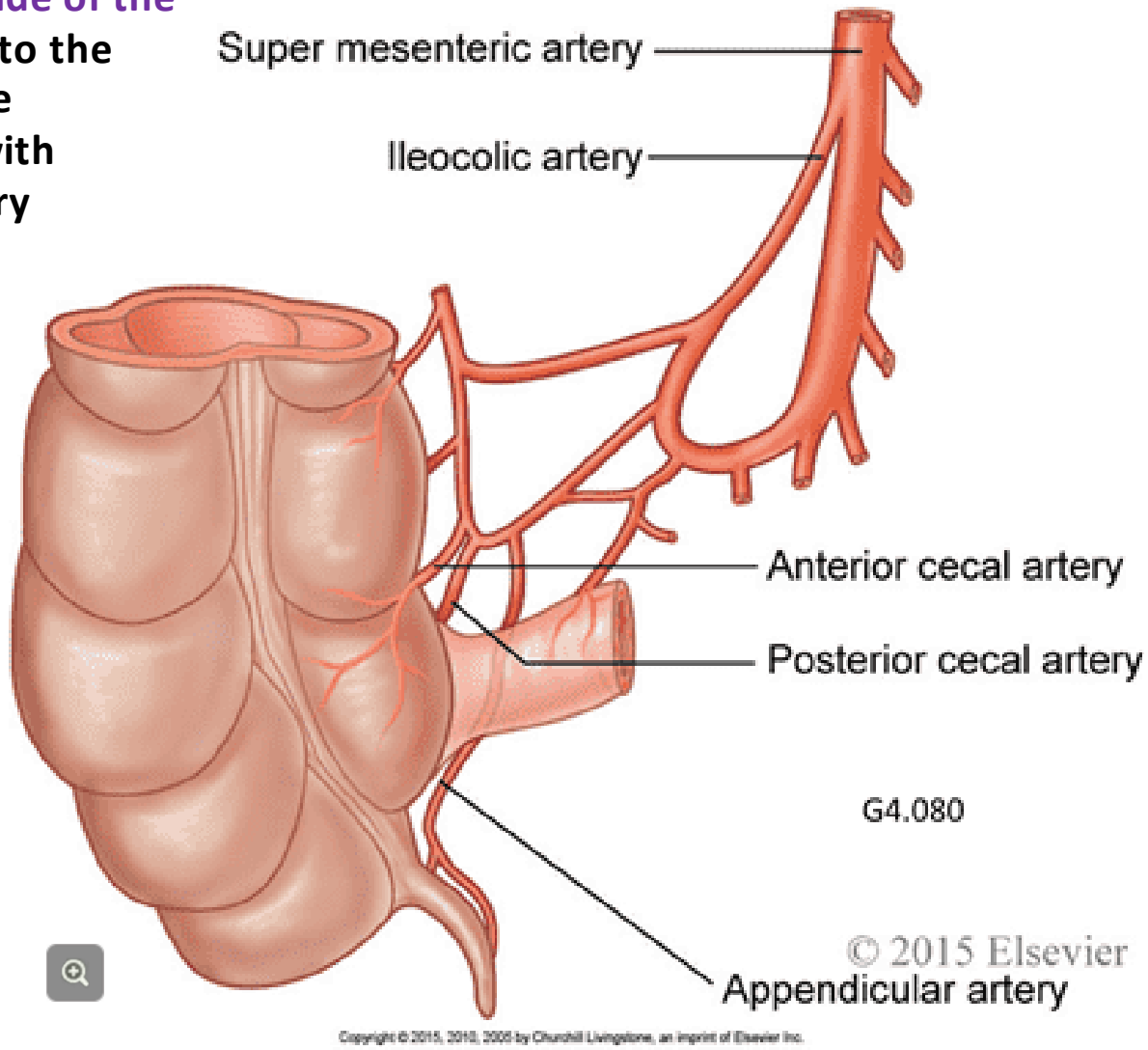
In comparing the two, you will notice that the jejunum has a simpler network of arcades that give rise to longer vasa recta (A), while the ileal arcades are much more complex, and give rise to shorter vasa recta (B).



TASK

IDENTIFY the ileocolic artery.

It courses obliquely, in a retroperitoneal position, from its point of origin on the right side of the SMA, toward the cecum. It gives rise to the appendicular artery, which runs within the mesoappendix. Observe its anastomoses with intestinal branches and with the next artery to be dissected, the right colic artery.

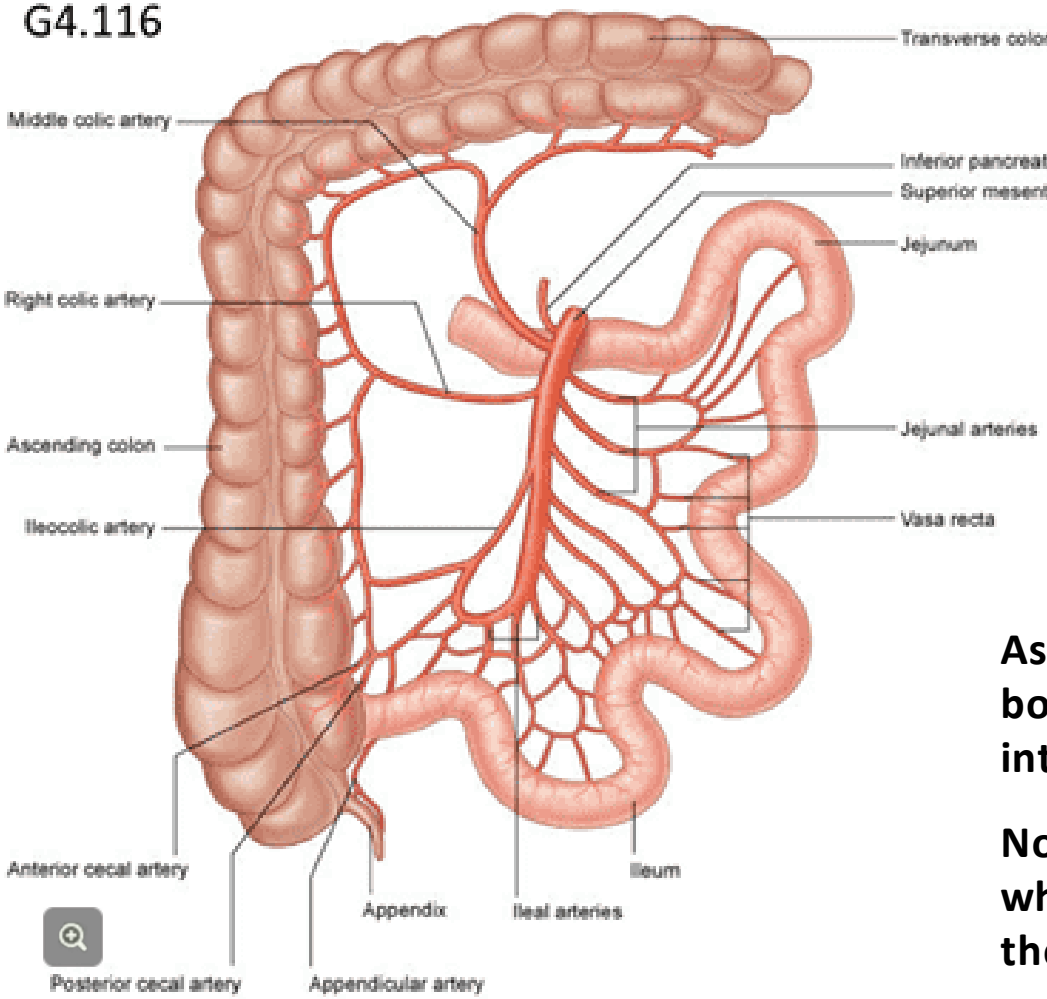


TASK

IDENTIFY the right colic artery,

which runs in a retroperitoneal position from the right side of the SMA to the (retroperitoneal) ascending colon. Note its inferior branch, which anastomoses with the ileocolic artery and its superior branch which anastomoses with the middle colic artery, to be dissected next.

G4.116



TASK

IDENTIFY the middle colic artery,

which is one of the first branches of the SMA after its branch to the duodenum and pancreas. It arises from the anterior surface of the SMA and enters the **transverse mesocolon** to supply the **transverse colon**.

As you did with the jejunal and ileal branches, clean both lamina of the transverse mesocolon and all intervening tissue to expose the middle colic artery.

Note that it gives rise to right and left branches, which anastomose with the right colic artery and the left colic artery of the IMA, respectively.

TASK

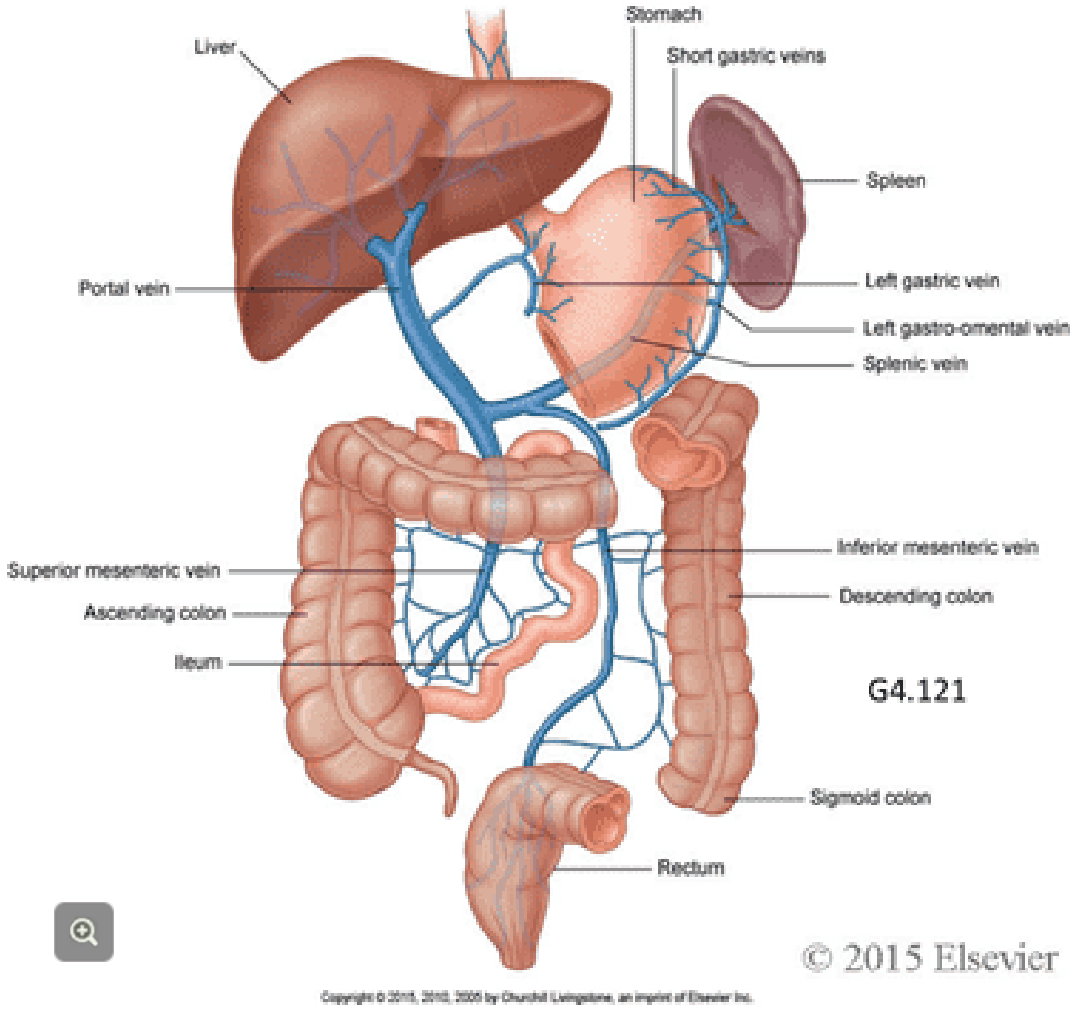
IDENTIFY the SMV, to the right of the SMA.

The names of the its tributaries correspond to those of the companion artery. **You should thus be able to recognize jejunal, ileal, ileocolic, right colic and middle colic veins. Trace the SMV superiorly, over the horizontal portion of the duodenum.**

The SMV drains the midgut to the hepatic portal system, which drains venous blood from the digestive tract to the liver. Later, you will dissect the region of the duodenum and pancreas and observe, directly, the **union of the SMV with the splenic vein** to form the **hepatic portal vein**.

This is a good time to review the lymphatic drainage of the midgut. Recall that **hundreds of lymph nodes** are associated with the field of the SMA. You will have removed many of them during this dissection.

The lymphatic channels that drain this field follow the branches of the SMA to the **superior mesenteric lymph nodes** in the region of the **junction of the SMA with the abdominal aorta**.



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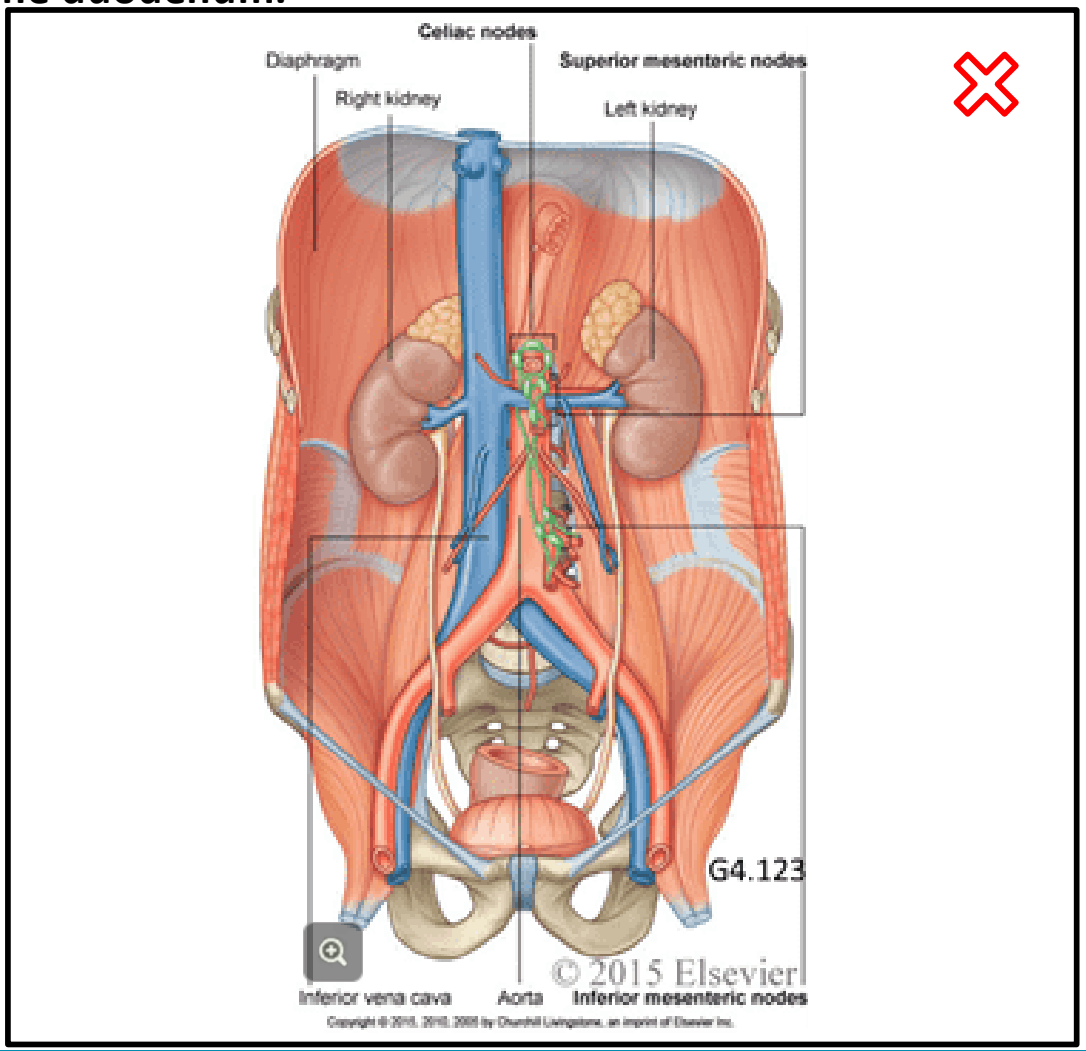
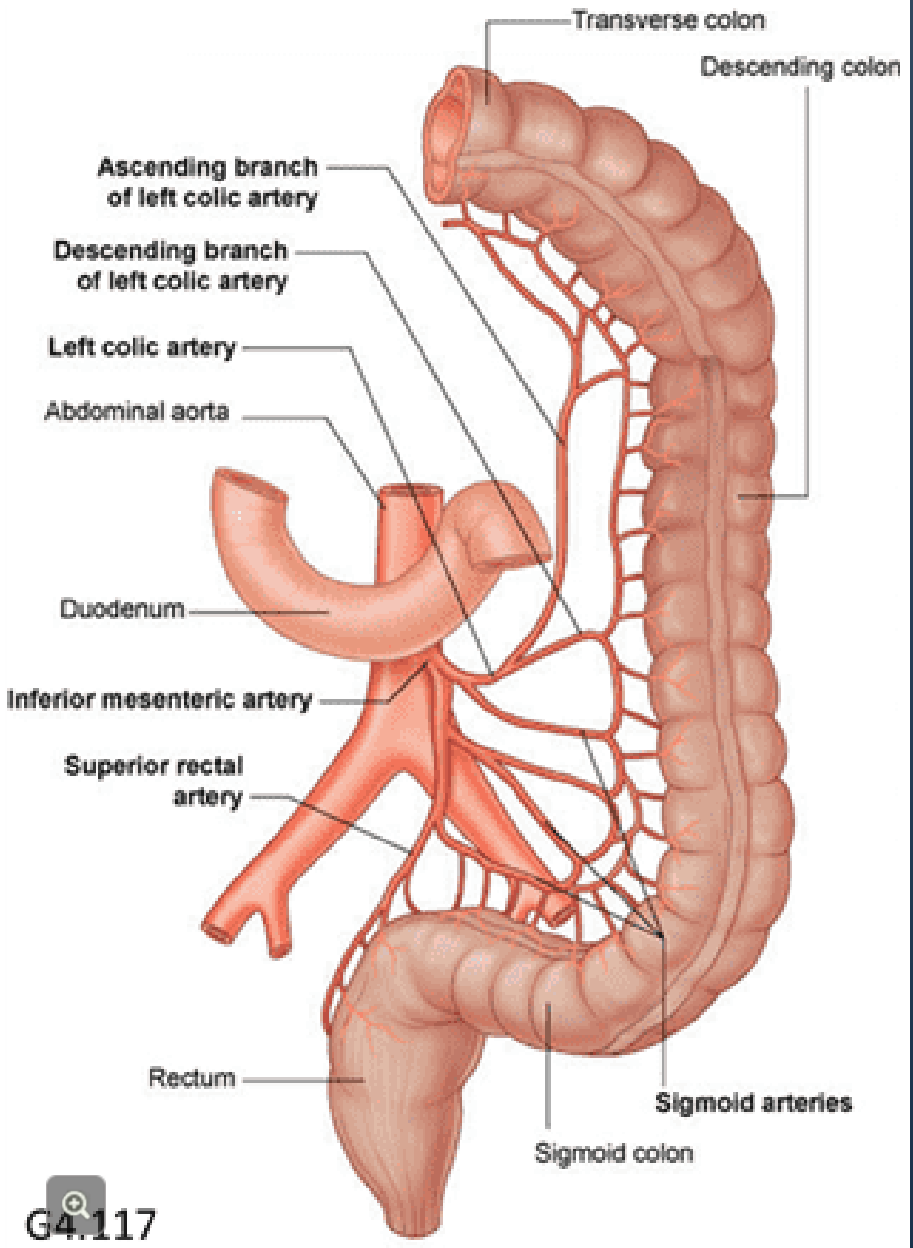


Since the last Progress Check, you have **dissected** and **clearly exposed** the following structures, and learned the answers to the following questions:

- jejunal arcades and vasa recta, ileal arcades and vasa recta; can you describe how these differ from each other anatomically? Can you differentiate them in a dissection?
- ileocolic artery, appendicular artery, right colic artery, middle colic artery and the anastomoses between each;
- SMV and tributaries; with what vein does the SMV unite? What larger vein is thus formed?
- What are the regional lymph nodes of the midgut?

If you are satisfied with the **quality of your dissection**, and your **ability to identify these structures** and **answer these questions**, call you TA over for confirmation and for permission to move on to the next stage of the dissection.

The IMA **arises from the anterior aspect of the abdominal aorta** at the level of the L3 vertebra, **posterior to the horizontal portion of the duodenum**. Its branches supply the distal (left) 1/3 of the transverse colon, the descending and sigmoid colon and the proximal rectum and are accompanied by veins which take the same name. **All of the branches of the IMA, with the exception of those that supply the (intraperitoneal) sigmoid colon, are retroperitoneal.**



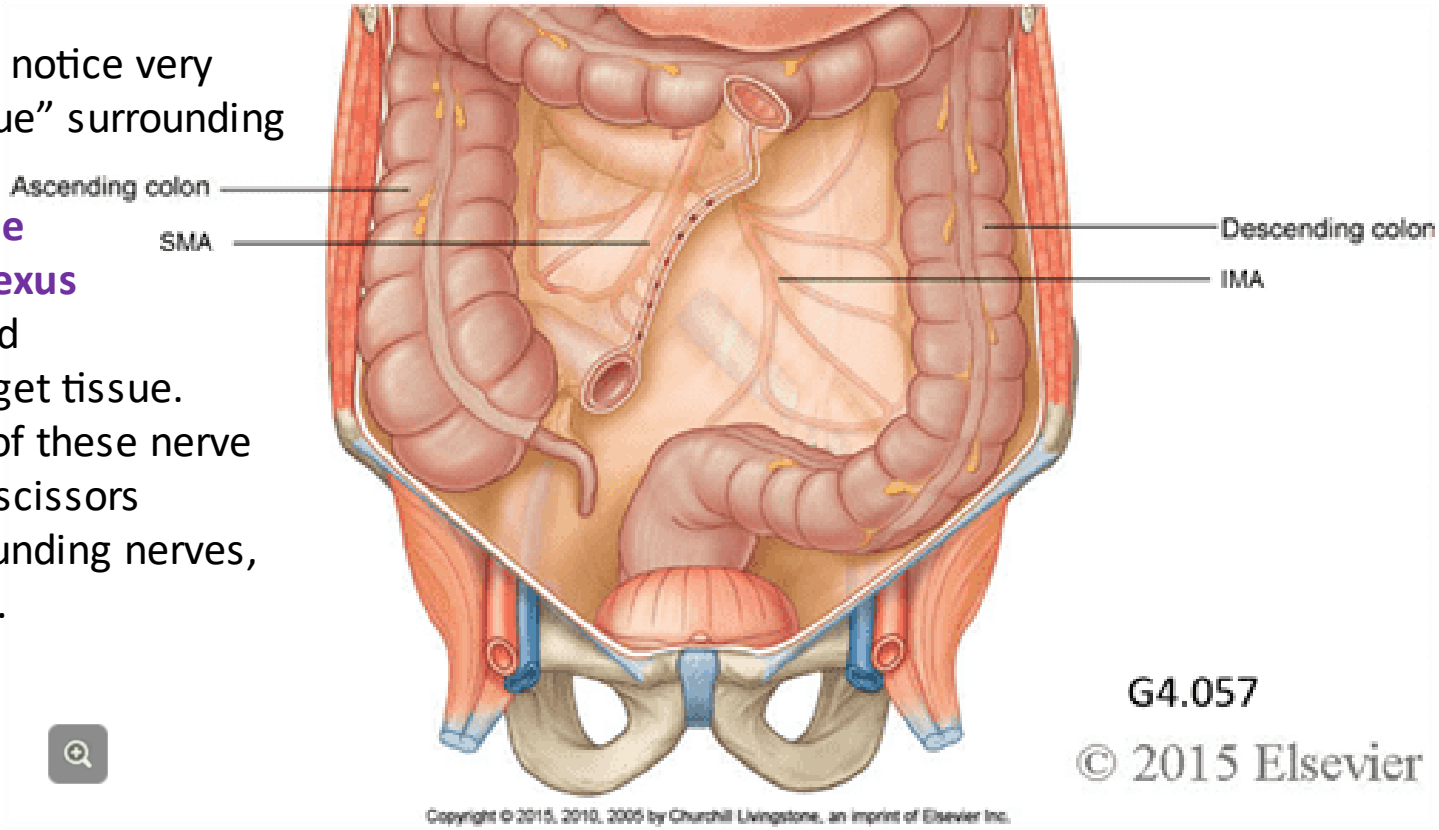
G4.117

TASK

REFLECT the small intestine to the right side of the abdomen,

revealing the descending colon from the splenic flexure to the sigmoid colon. Identify the left paracolic gutter lateral to the descending colon. Identify the parietal peritoneum overlying the posterior abdominal wall from the root of the mesentery to the medial border of the descending colon. Run your fingers over the parietal peritoneum to identify, by feel, either the IMA itself or one of its major branches. Break through the peritoneum with a probe or large forceps and tear it back to reveal the vessels.

Again, as you dissect, you will notice very dense, tough "connective tissue" surrounding the vessels. Again this is the **autonomic nerve fibres of the of the inferior mesenteric plexus** which travel along the IMA and its branches to reach their target tissue. Clean the vessels thoroughly of these nerve fibres by sliding large, closed scissors between the vessel and surrounding nerves, and then opening the scissors.



TASK

USING blunt dissection techniques, thoroughly

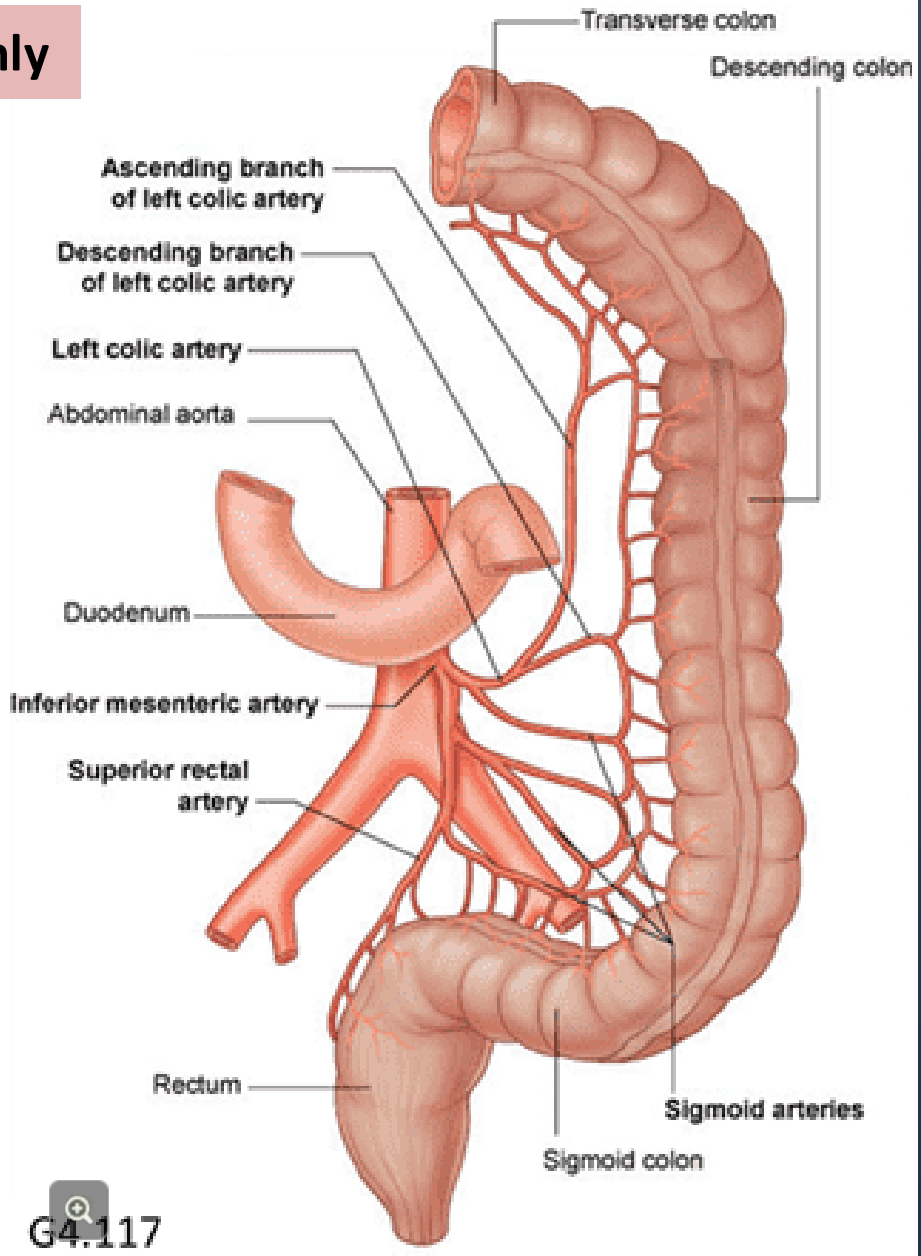
clean the IMA and IMV, and their branches. Clean and identify the left colic artery, which supplies the descending colon. Identify its ascending branch extending toward the left colic flexure to supply the distal third of the transverse colon. It anastomoses with the SMA via the left branch of the middle colic artery, thus forming the marginal artery.

Identify and clean the descending branch of the left colic artery. It anastomoses with the first sigmoid artery.

Identify and clean the sigmoid arteries, three or four vessels that run in the sigmoid mesocolon to supply the sigmoid colon.

Thoroughly dissect both laminae of the sigmoid mesocolon, removing all intervening tissue. This will reveal the characteristic architecture of the sigmoid arteries, which form arcades, much like the intestinal arteries.

Identify the terminal branch of the IMA, the superior rectal artery. It divides into right and left branches which pass into the pelvis on either side of the rectum.



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TASK

USING blunt dissection techniques, thoroughly clean the IMA and IMV, and their branches. Clean and identify the left colic artery, which supplies the descending colon. Identify its ascending branch extending toward the left colic flexure to supply the distal third of the transverse colon. It anastomoses with the SMA via the left branch of the middle colic artery, thus forming the marginal artery.

Identify and clean the descending branch of the left colic artery. It anastomoses with the first sigmoid artery.

Identify and clean the sigmoid arteries, three or four vessels that run in the sigmoid mesocolon to supply the sigmoid colon.

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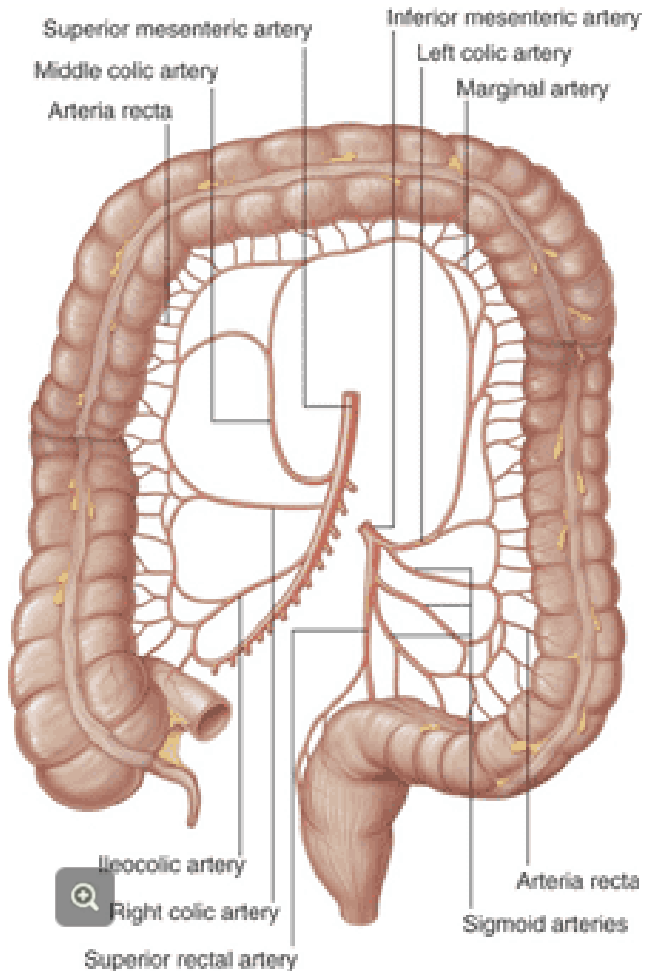


The major anastomosis between the SMA and IMA is the **marginal artery**. It connects the **middle colic artery** (from the SMA) with the **left colic artery** (from the IMA) around the splenic flexure of the large intestine.

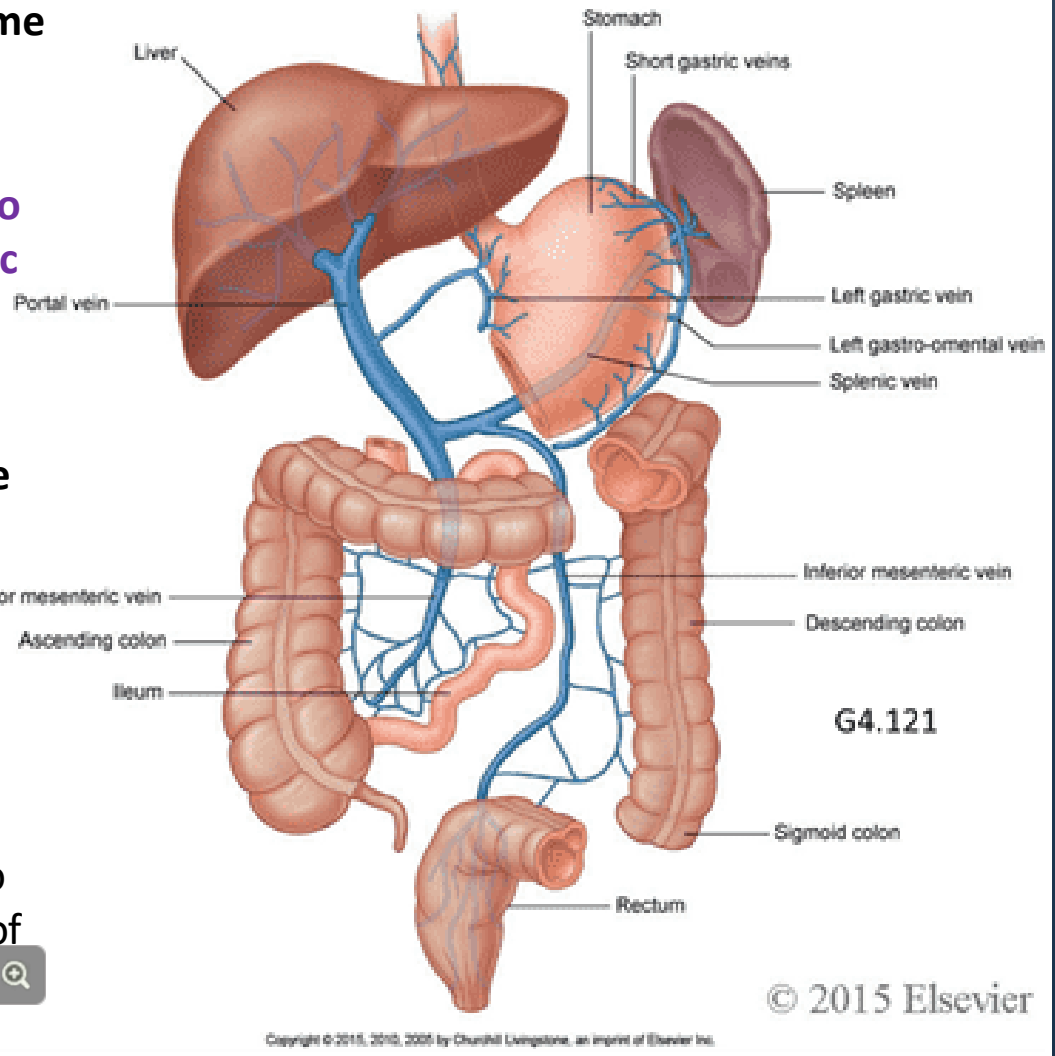
TASK

IDENTIFY the IMV to the left of the IMA.

The IMV drains blood from the hindgut to the hepatic portal system. Identify the tributaries of the IMV accompanying, and taking the same names as, the branches of the IMA. Thus, identify the superior rectal, sigmoid and left colic veins.

Clean the IMV superiorly until it passes posterior to the pancreas. The IMV usually drains into the splenic vein, which then joins the SMV to form the hepatic portal vein. In a common variation, the IMV empties into the SMV at the point where it joins the splenic vein. **Clear the IMV a little further, posterior to the pancreas and determine which of these variations exist in your cadaver.**

Recall that **hundreds of lymph nodes** occupy the field of the IMA within the retroperitoneum and the sigmoid mesocolon. You will have removed many of them during dissection. The lymphatic channels that drain this field follow the branches of the IMA to the **inferior mesenteric lymph nodes** in the region of the **junction of the IMA with the abdominal aorta**.



TASK

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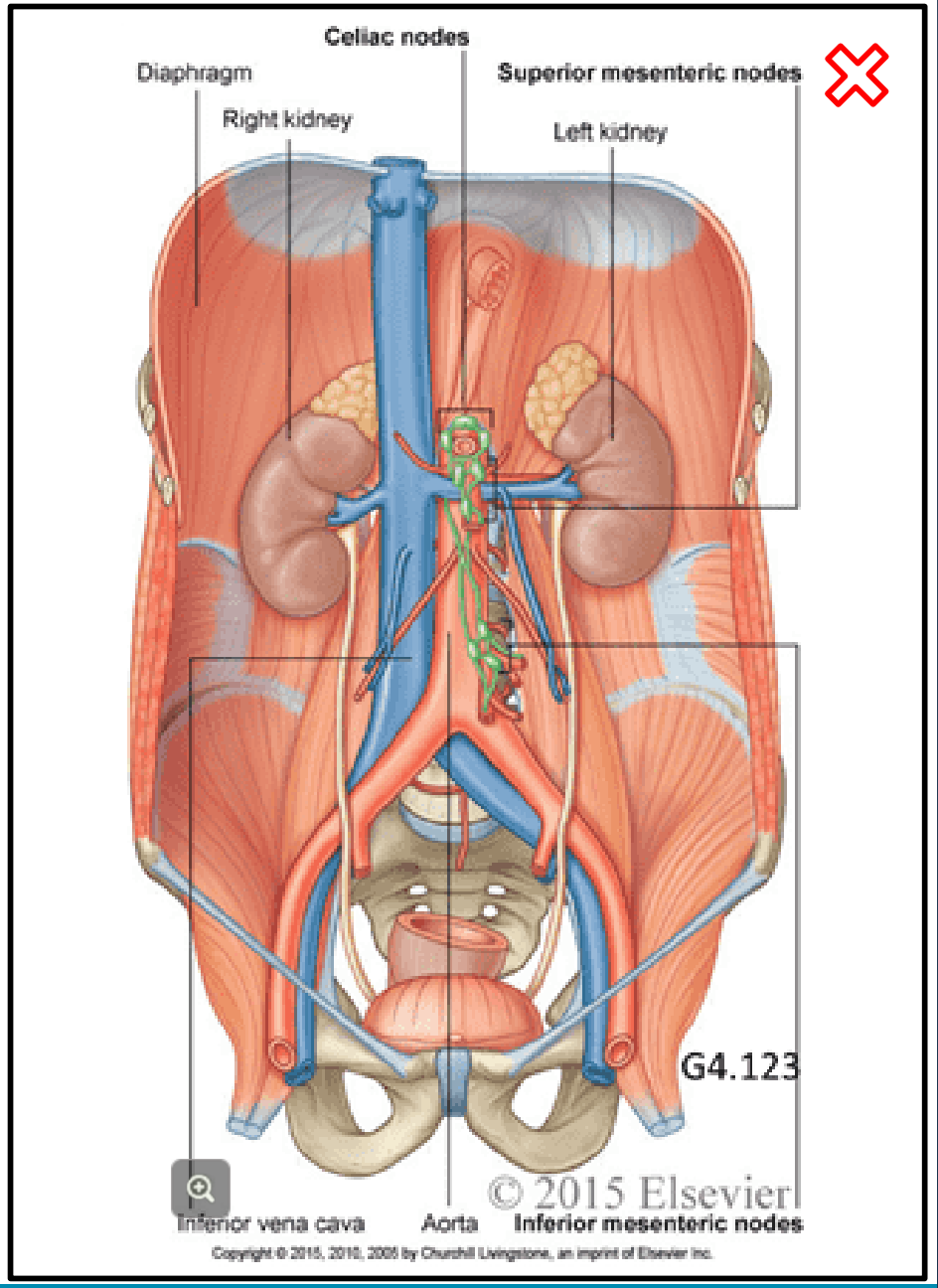


Since the last Progress Check, you have **dissected** and **clearly exposed** the following structures, and learned the answers to the following questions:

- the left colic artery and its anastomosis with the middle colic artery via the marginal artery
- the sigmoid arteries, their arcades and vasa recta
- the superior rectal artery
- the IMV and its tributaries, the superior rectal, sigmoid and left colic veins
- the union of the IMV with the portal venous system

- Into what major vein does the SMV usually empty? Describe a common variation of this venous architecture.
- What are the regional lymph nodes of the hindgut?

Pause here to assess your learning. Quiz each other thoroughly. If you are satisfied with your ability to **identify these structures** and **answer these questions**, move on to the next phase of the exercise.

TASK

REFLECT the stomach superiorly over the costal margin.

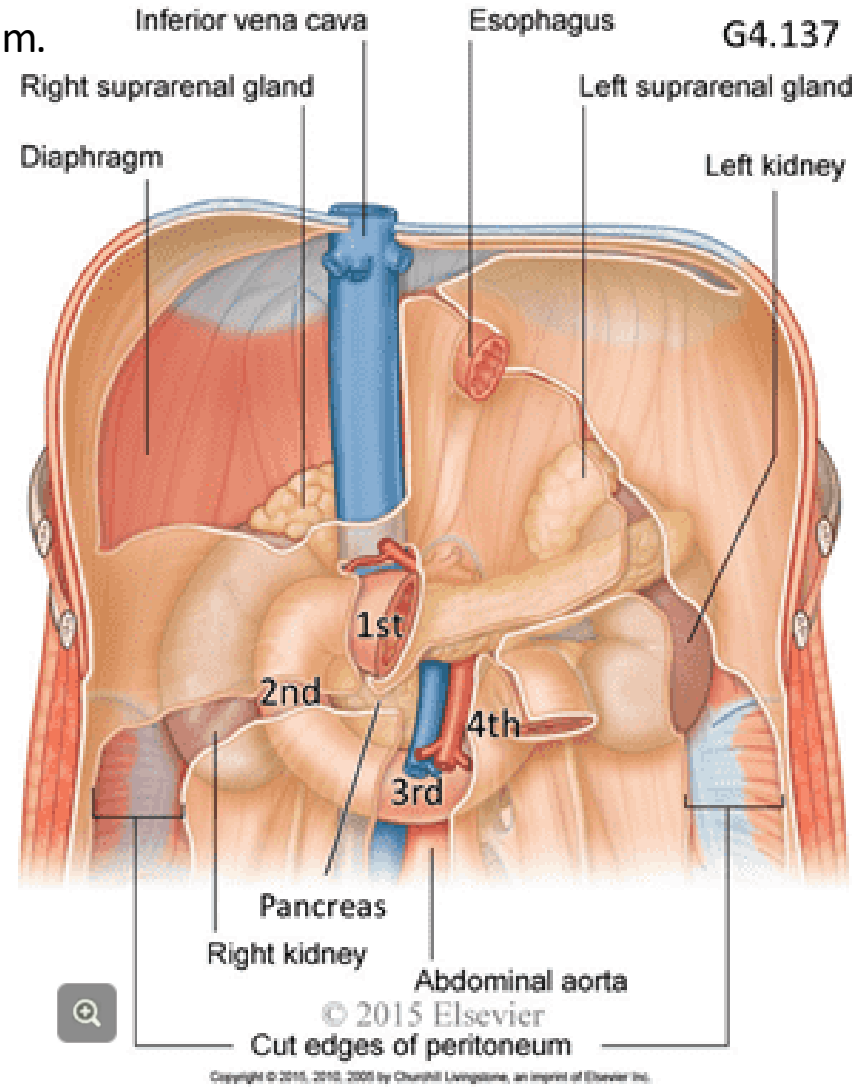
Either reflect the transverse colon superiorly as well, or keep the transverse colon down; your goal is to achieve the widest possible access to the pancreas and duodenum. You can put the stomach and transverse colon back into position when you later want to review their blood supply.

Using blunt dissection, thoroughly clean the anterior surface of the duodenum and pancreas. The connective tissue and peritoneum you are removing are remnants of the transverse mesocolon.

One person on the cadaver's right side will start at the gastroduodenal junction, and one person on the left side will start at the duodenojejunal junction.

As you work, identify the four parts of the duodenum, and make note of the following details:

The 1st (superior) part runs horizontally to the right and lies at level of the L1 vertebra. Its expanded initial part is the ampulla, often called the **duodenal cap** or duodenal bulb by clinicians. Recall that this part of the duodenum is largely **intraperitoneal**, being located in the **hepatoduodenal ligament**.



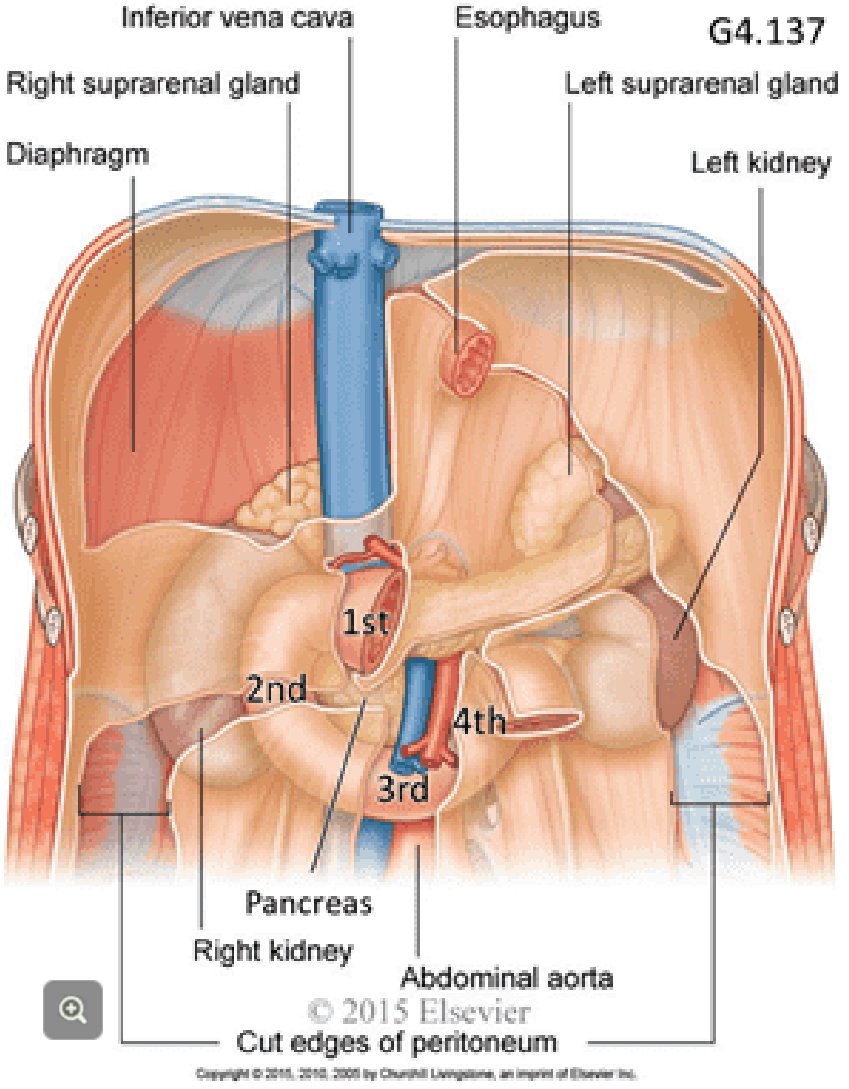
TASK

Continue to work, noting the details regarding the different parts of the duodenum:

The 2nd (descending) part lies to the right of the midline, at the level of the **L2 vertebra**, anterior to the **hilum of the right kidney, right renal vessels, and inferior vena cava.** It, like the remainder of the duodenum, is retroperitoneal. The 2nd part of the duodenum **receives the common bile duct and pancreatic duct.**

The 3rd (horizontal) part crosses the abdomen horizontally from right to left at the level of the **L3 vertebra.** Notice that it lies anterior to the **inferior vena cava** and the **abdominal aorta,** and posterior to the **superior mesenteric vessels.**

The 4th (ascending) part ascends to the **L2 vertebral level.** The ascending part of the duodenum turns anteriorly to emerge from the posterior body wall where it is continuous with the jejunum at the **duodenojejunal junction.**



The pancreas crosses the midline at the level of the L1 to L3 vertebral bodies.

TASK

Thoroughly clean the pancreas

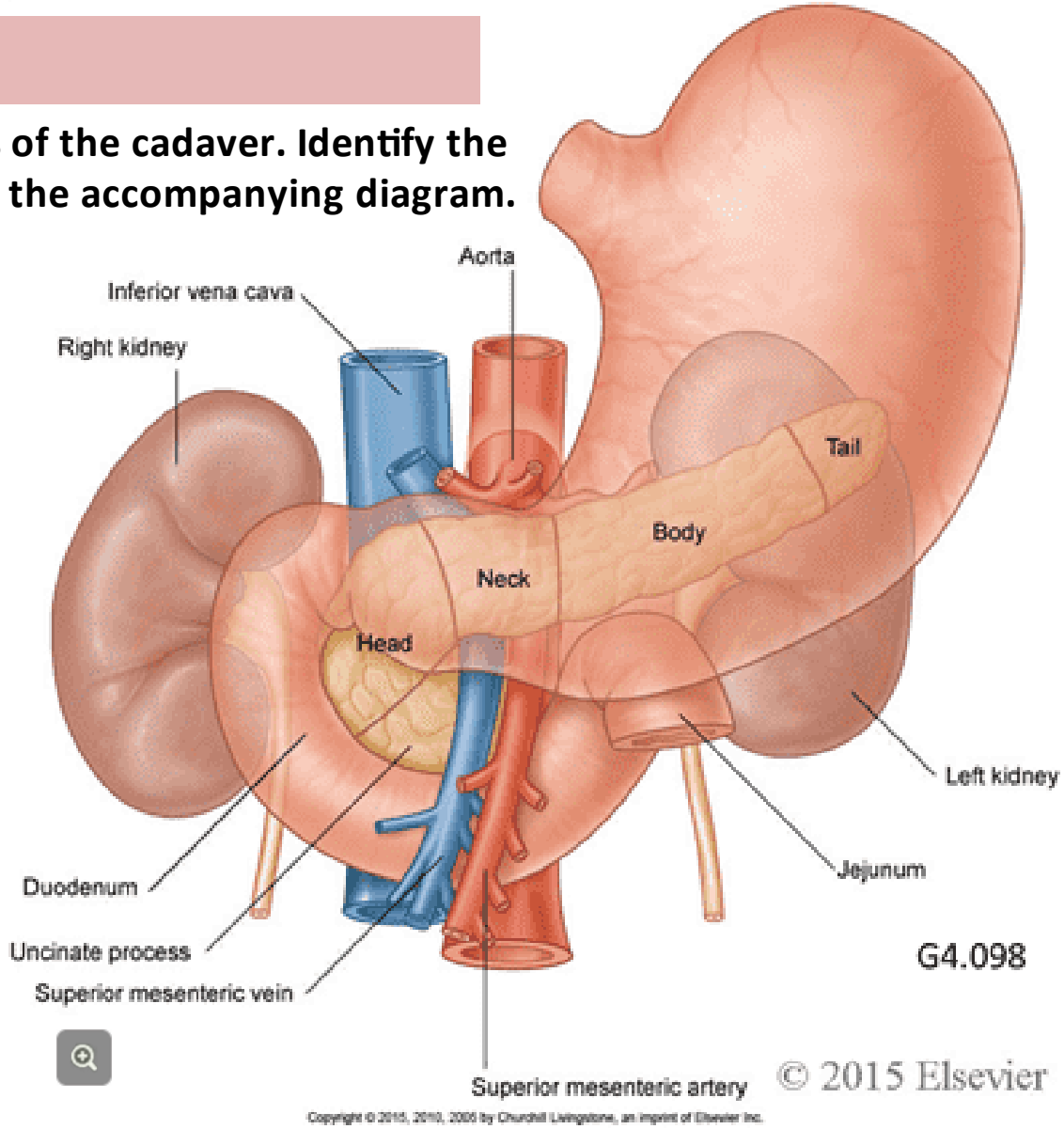
Again, students will work on both sides of the cadaver. Identify the parts of the pancreas with reference to the accompanying diagram.

Notice that its head occupies the curve of the duodenum and lies anterior to the IVC.

Identify the uncinate process extending from the head of the pancreas posterior to the superior mesenteric vessels and anterior to the abdominal aorta.

Identify the neck of the pancreas anterior to the SMA and SMV, and its body extending to the left, sloping slightly superiorly.

Note the tail of the pancreas extending toward the hilum of the spleen. The tip of the tail of the pancreas, which lies within the splenorenal ligament, is intraperitoneal, and contacts the hilum of the spleen.



TASK

Turn your attention to the common bile duct

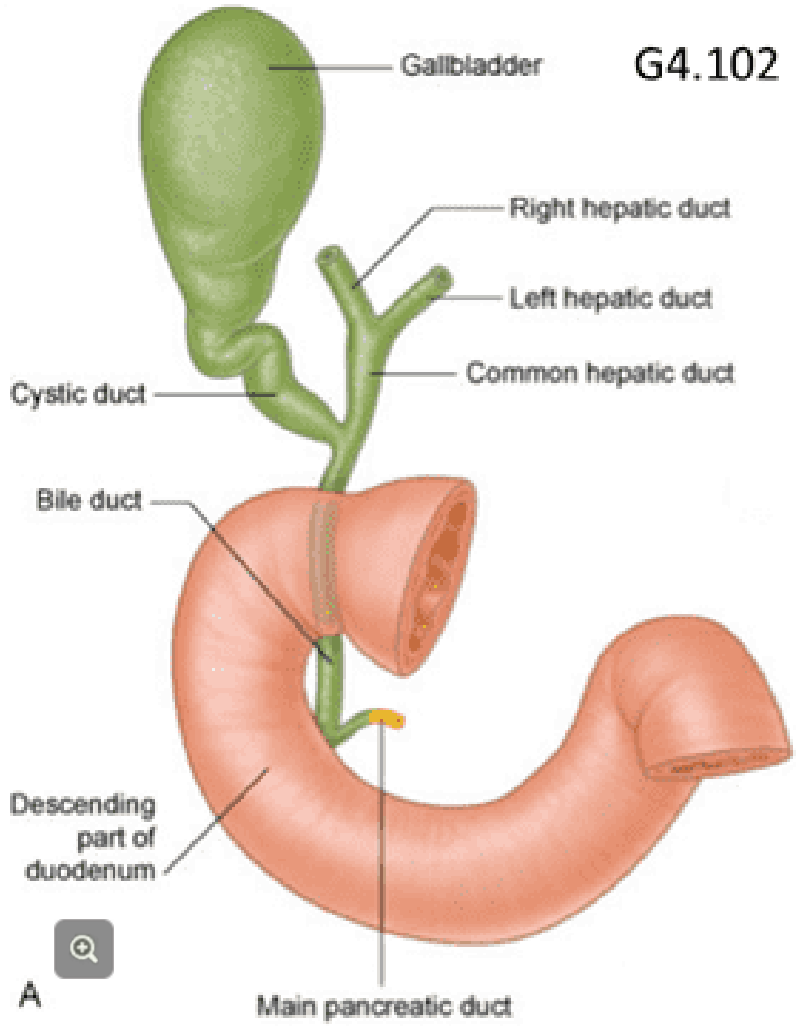
and dissect it both toward the porta hepatis and toward the 2nd part of the duodenum.

TASK

Notice here that in the

hepatoduodenal ligament, the common bile duct is to the right of the hepatic artery proper and. anterior to the hepatic portal vein

As you clean the duct system toward the porta hepatis, identify the formation of the common bile duct by the union of the cystic duct with the common hepatic duct. Follow the common hepatic duct into the porta hepatis and identify its formation by the union of the right end left hepatic ducts.



TASK

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TASK

Notice here that in the hepatoduodenal ligament, the common bile duct is to the right of the hepatic artery proper and. anterior to the hepatic portal vein

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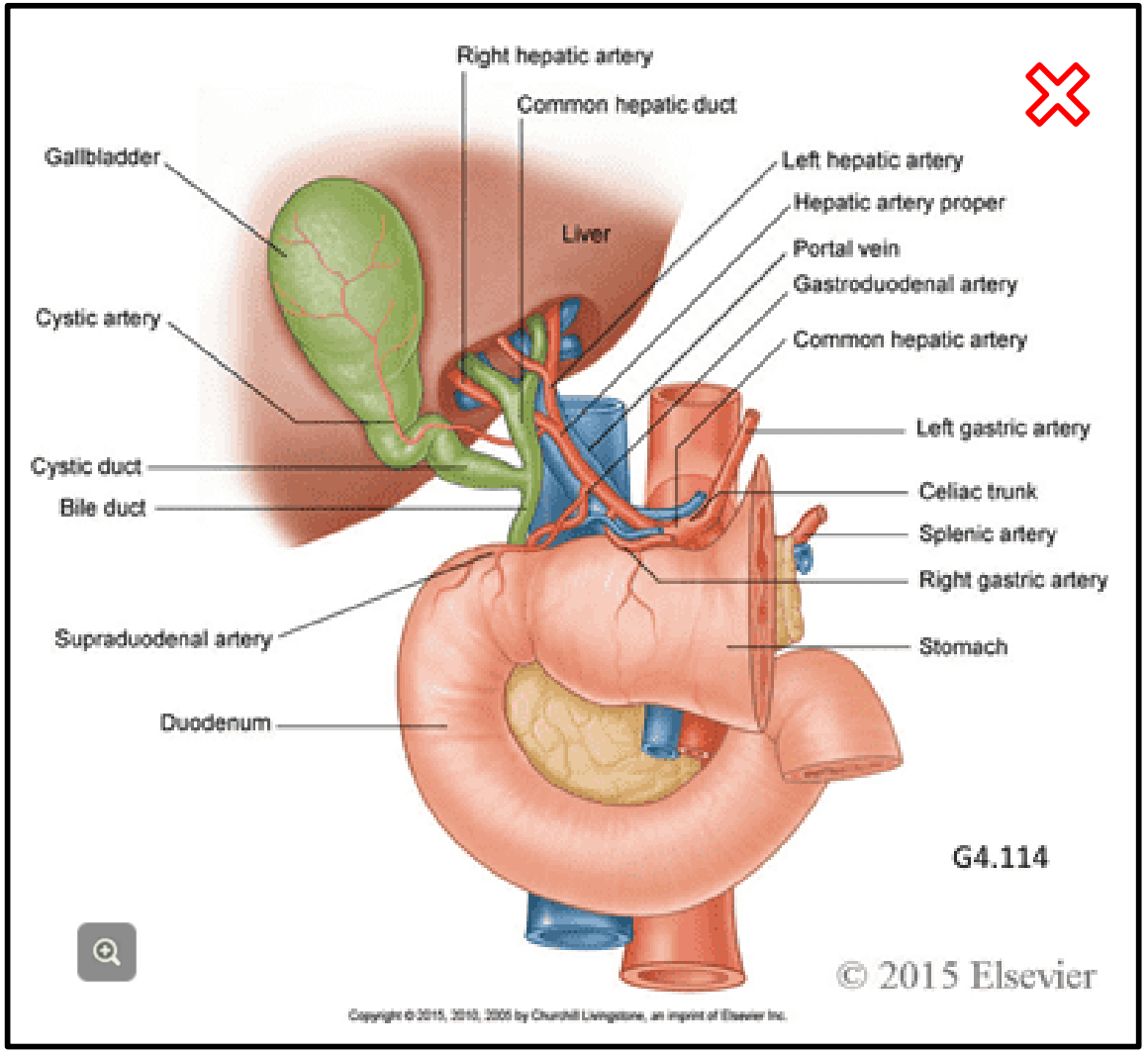


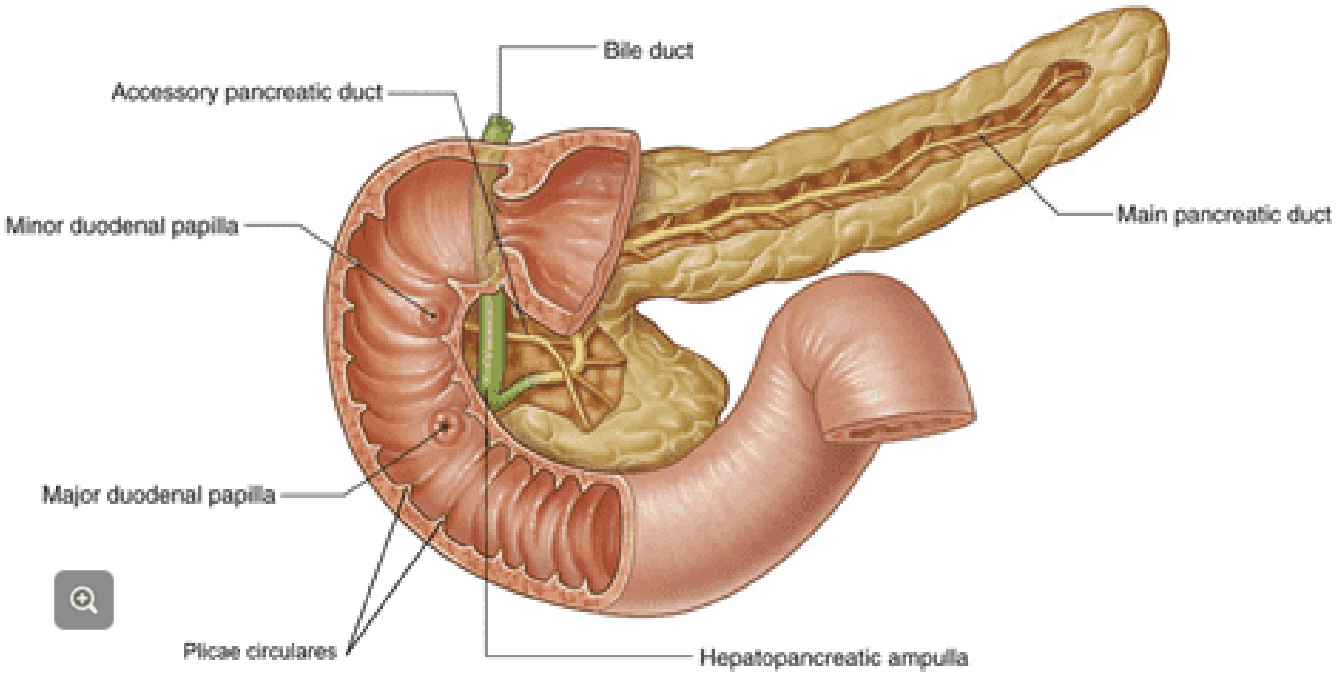
Within the head of the pancreas, the **common bile duct** unites with the **main pancreatic duct**, thus forming the **hepatopancreatic ampulla**. It empties into the **2nd part of the duodenum** at the **major duodenal papilla**. The papilla is formed by a ring of smooth muscle, the **hepatopancreatic sphincter**, which controls the flow of bile and pancreatic juice into the duodenum.

TASK

Dissect the common bile duct posterior to the 1st part of the duodenum

It might help to reflect the duodenum to the left. Continue until the common bile duct meets the wall of the 2nd part of the duodenum.

Bisect the pancreas through the junction between its head and neck. Your cut should pass to the right of the SMV. Be careful to leave intact the SMA and SMV. Look into the cut edge of the head of the pancreas and identify the lumen of the main pancreatic duct. Using a blunt probe and forceps, dissect the pancreatic duct through the head of the pancreas toward the 2nd part of the duodenum. Look for the accessory pancreatic duct, which joins the main duct from above. Locate the point at which the main pancreatic duct unites with the common bile duct, at the wall of the 2nd part of the duodenum.



TASK

Identify the vessels running in the curve of the duodenum, anterior and posterior to the head of the pancreas, the anterior and posterior pancreaticoduodenal arteries. They form an anastomosis between the celiac trunk and the SMA.

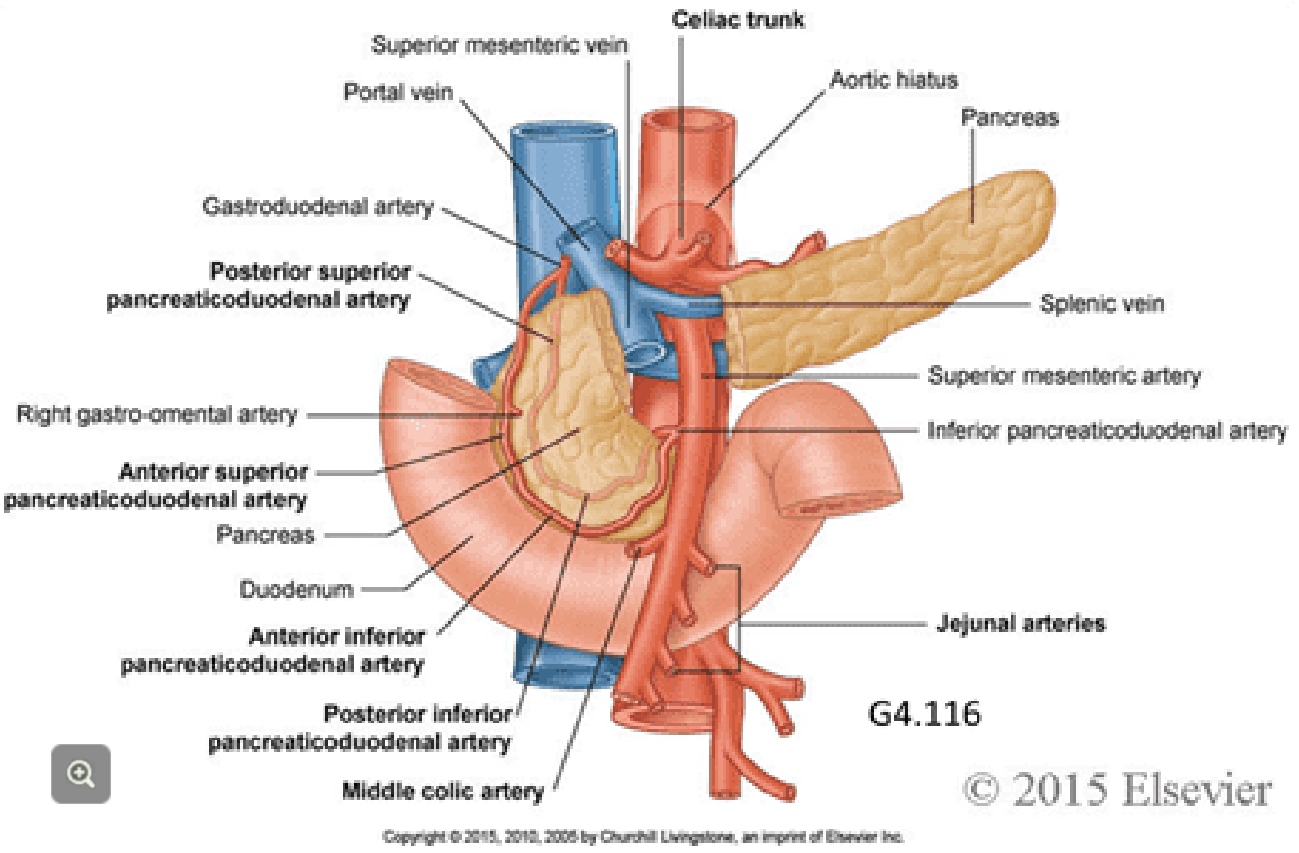
The anterior and posterior **superior** pancreaticoduodenal arteries arise from the **gastroduodenal** artery. **Trace the gastroduodenal artery back to the common hepatic artery and celiac trunk.**

The anterior and posterior **inferior** pancreaticoduodenal arteries usually arise from the **first branch of the SMA**. Can you locate their origin?

TASK

From the celiac trunk, trace the splenic artery to the left to uncover the blood supply to the tail of the pancreas .

Notice that the splenic artery wends its way along the superior border of the pancreas and **provides branches to its body and tail**. **Follow the splenic artery to the hilum of the spleen and confirm the origin of the left gastro-omental (gastroepiploic) artery from the splenic artery.**



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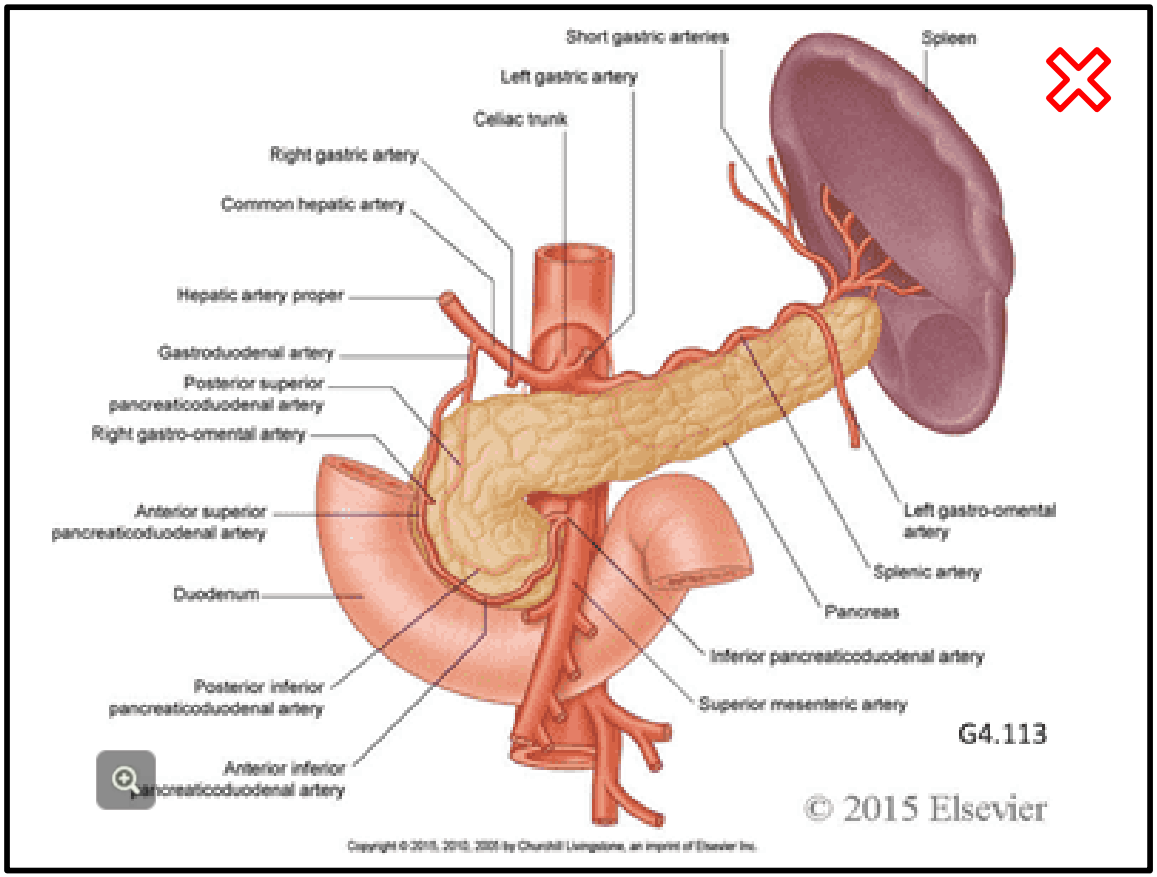


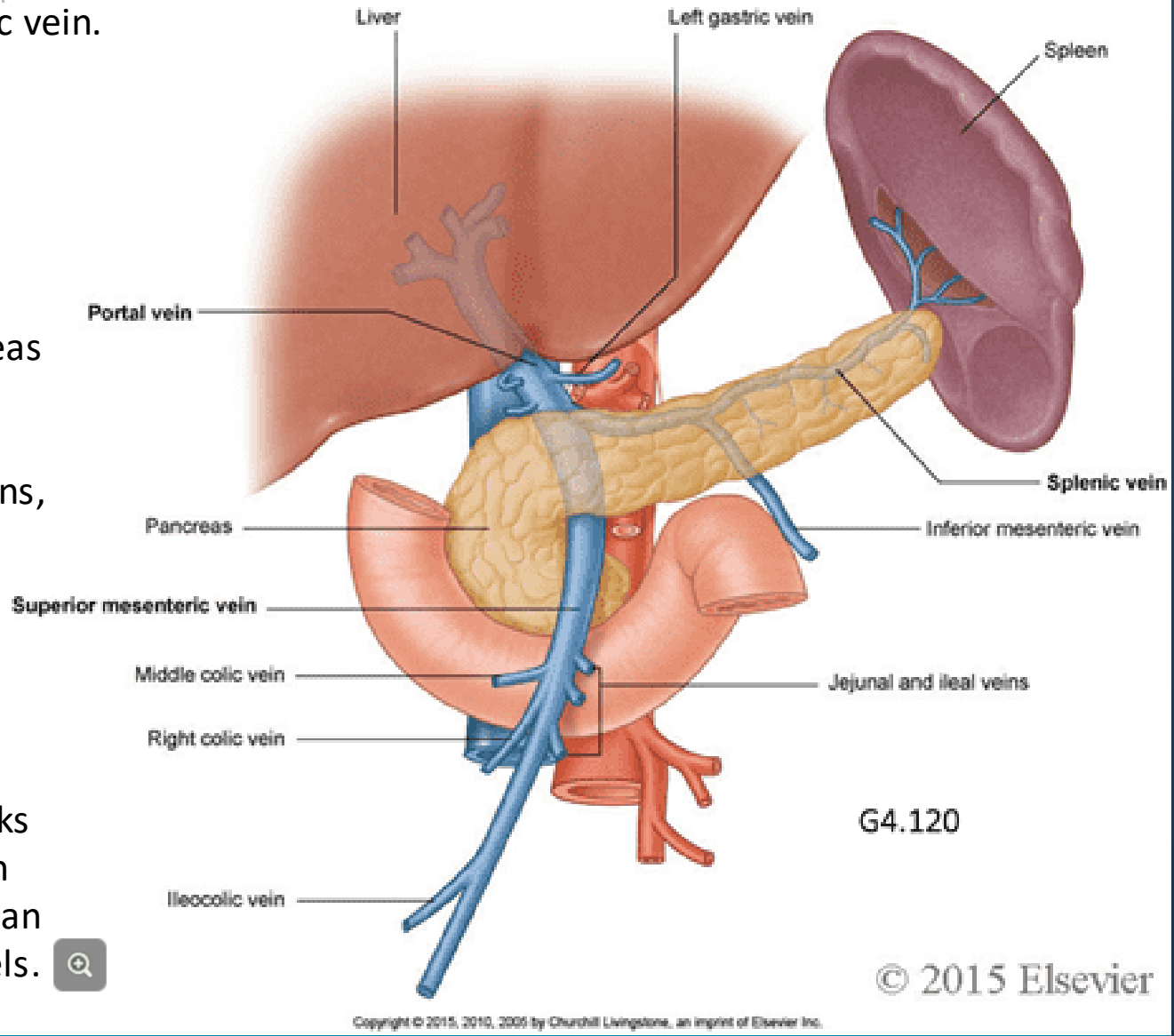
The veins of the pancreas follow the arteries. Look at the accompanying diagram to make sense of the following: veins draining the head, neck and uncinate process empty into the SMV and veins draining the body and tail drain into the splenic vein.

Posterior to the neck of the pancreas, the splenic vein joins the SMV to form the hepatic portal vein.

The **hepatic portal system** of veins drains the abdominal portion of the digestive system, including the pancreas and the spleen, to the liver. The liver processes and detoxifies this blood before emptying it, via the hepatic veins, into the caval system.

Clinically important points of portal-systemic (portal-caval) anastomosis are the **gastroesophageal**, **anorectal** and **paraumbilical** anastomoses.

Because the portal venous system lacks valves, **portal hypertension** results in **engorgement of its tributaries** that can extend into these anastomotic channels.



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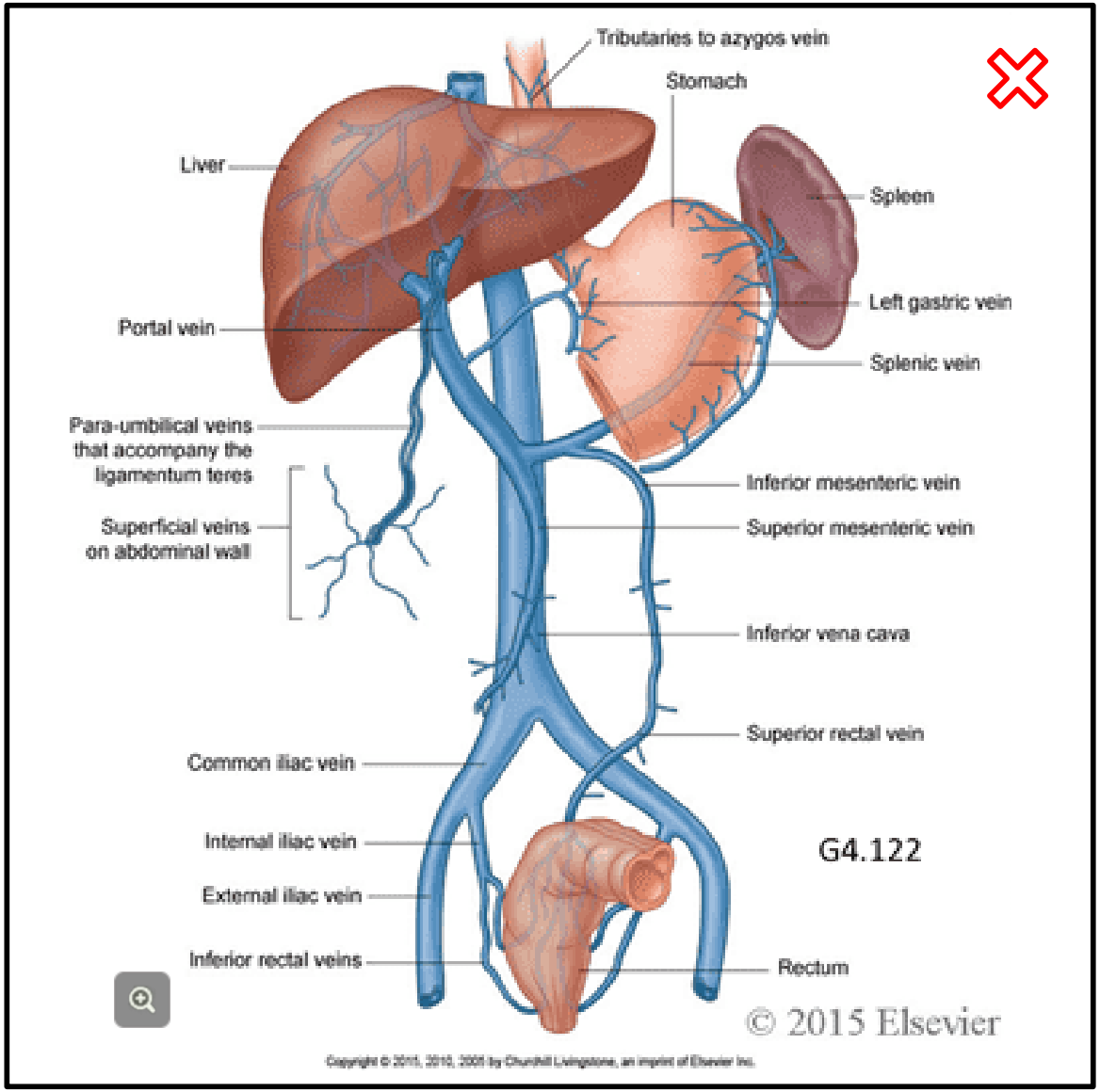


With the pancreas bisected and reflected to either side, you have wide access to study the formation of the hepatic portal vein.

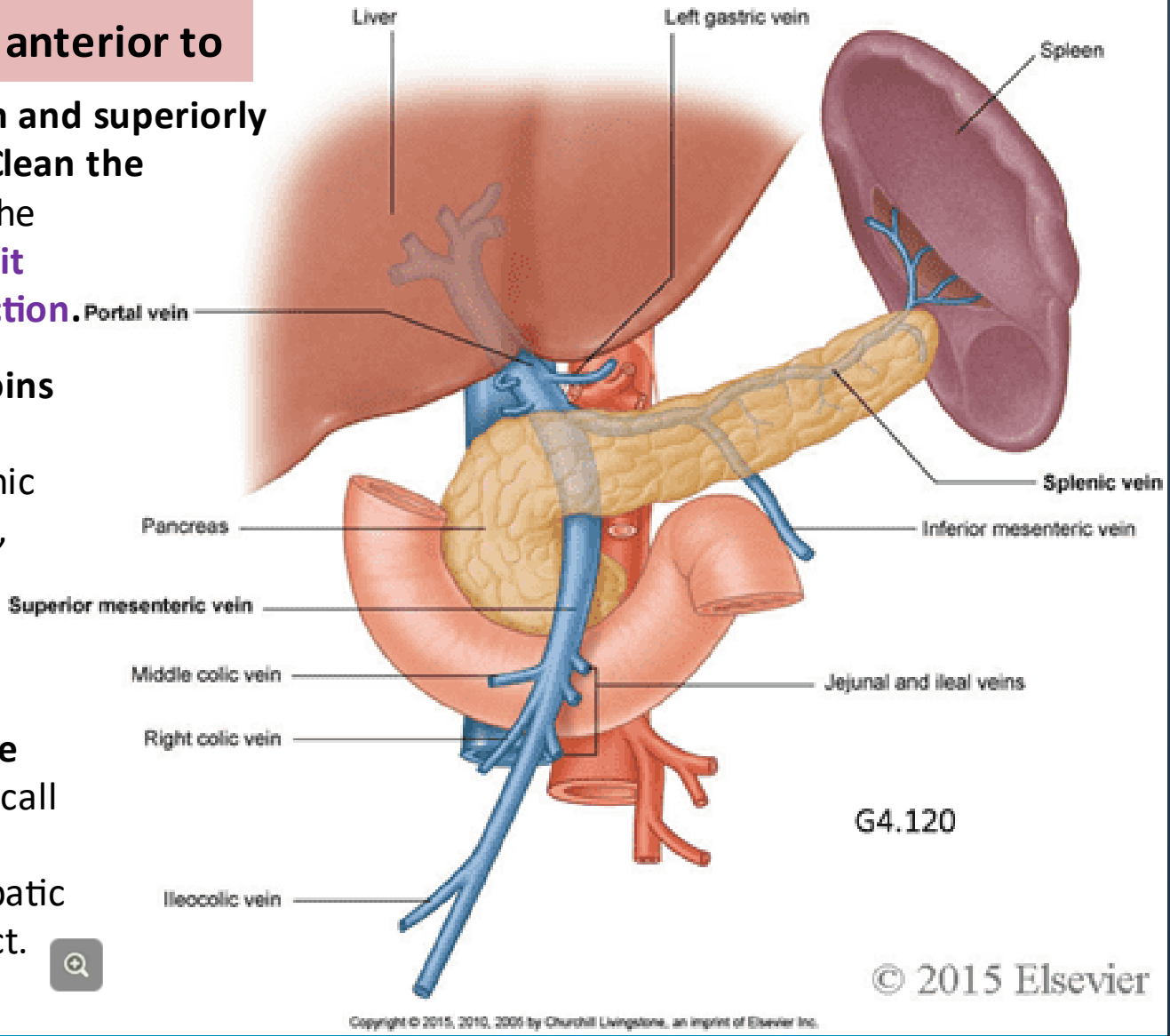
TASK

Clean the SMV as it passes anterior to

to the 3rd part of the duodenum and superiorly until it meets the splenic vein. Clean the splenic vein. It is often embedded in the body and tail of the pancreas. **Extract it from the pancreas using blunt dissection.**

Locate the point at which the IMV joins the portal system. In the majority of people, the IMV empties into the splenic vein, although in a significant minority, it empties into the SMV or into the point at which the SMV and splenic veins unite.

Clean the hepatic portal vein into the porta hepatis where it bifurcates. Recall that the hepatic portal vein runs in the hepatoduodenal ligament with the hepatic artery proper and the common bile duct.



So far, you have **dissected** and **clearly exposed** the following structures and learned the **answers to the following questions**:

- the four parts of the duodenum; Which part of the duodenum is intraperitoneal? In what ligament is this part located? Which part of the duodenum is associated with the hilum of the right kidney, the renal vessels and IVC? Which part of the duodenum passes between the IVC/aorta and the SMV/SMA?
- the head, neck, body, tail and uncinate process of the pancreas; Which part of the pancreas is intraperitoneal? In what ligament is this part located? Which part of the pancreas is associated with the curve of the duodenum? Which part of the pancreas passes between the IVC/aorta and the SMV/SMA? Which part of the pancreas passes anterior to the SMV/SMA? Which part of the pancreas is associated with the hilum of the left kidney?
- common bile duct, cystic duct (if gall bladder is present), common hepatic duct, and right and left hepatic ducts; the main pancreatic duct and its union with the common bile duct; Into which part of the duodenum does the common bile duct and pancreatic duct empty?
- the portal vein, its right and left branches, the splenic vein, the SMV and IMV
- Can you describe the blood supply to the pancreas and duodenum?
- Can you describe the position of the pancreas and duodenum relative to the lesser sac? Therefore, which of their surfaces are covered with visceral peritoneum?

If you are satisfied with the **quality of your dissection**, and your **ability to identify these structures** and **answer these questions**, call you TA over for confirmation and for permission to clean up.