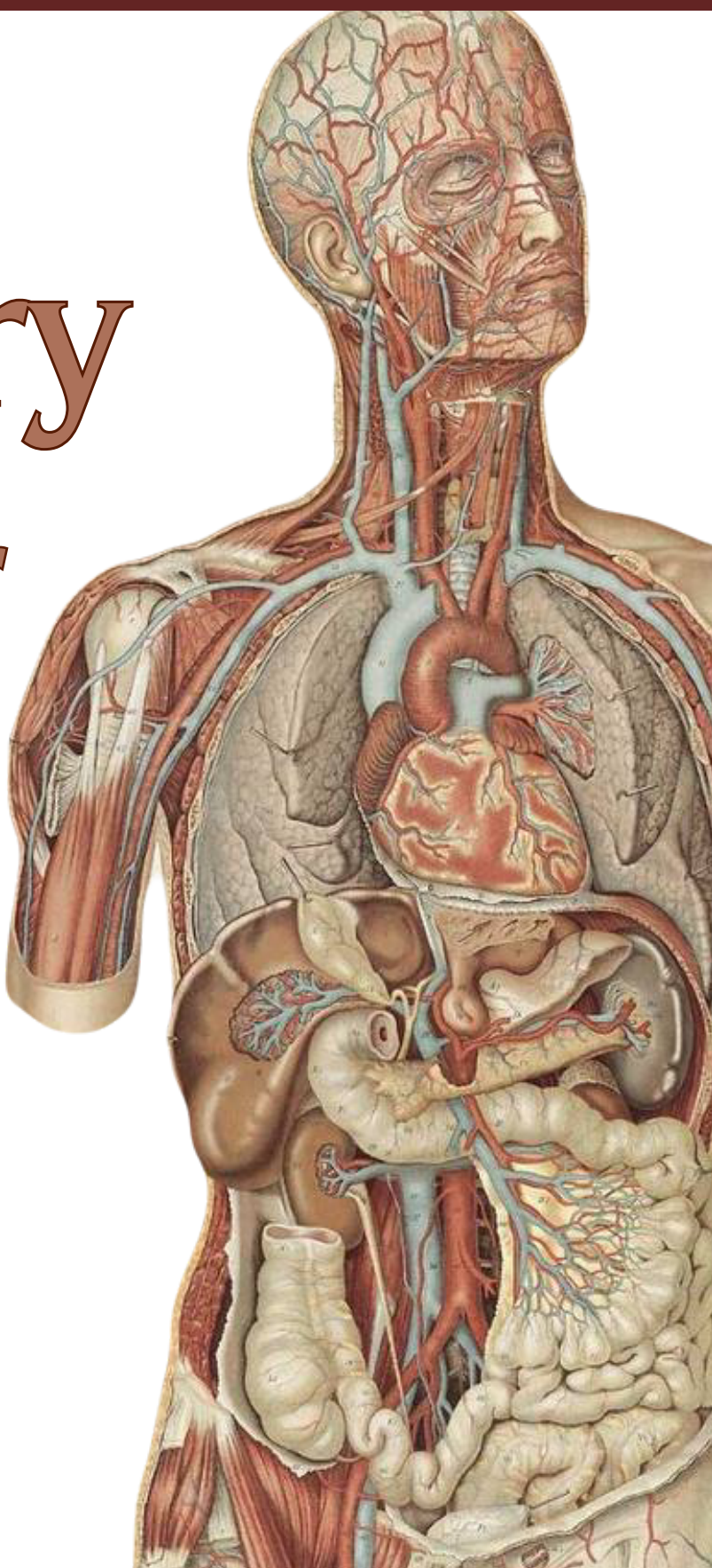
Anatomy

For

Surgery Dossier



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Anatomy Basics – For Surgery

«ولم أجِدِ الإنسَانَ إلا ابنَ سَعْيِهِ

فمَن كانَ أسعَىٰ كانَ بالمَجْدِ أجدَرا .

وبالهِمَّةِ العَلياءِ يَرْقَى إلىٰ العُلا

فمن كانَ أرقَىٰ هِمَّةً كانَ أظهَرا.»

-نظرًا لأهميّة مادة الأناتومي في ميجر الجراحة ، وتكرار الاسئلة عليها من الدكاترة في الراوندات وكذلك في اسئلة الامتحان وخاصة الفاينل ، تمّ بفضل الله إنجاز دوسية خاصة لاناتومي الجراحة بحيث تُسهِّل على الطالب دراسة الموضوع الذي يحتاجه وتوفّر وقت البحث وتمّ التركيز على كل المواضيع التي تكررت الاسئلة عليها ✔ .

-تمّ تحضيرها من مصادر ومواقع طبية موثوقة مثل:

✔ Amboss and teach me anatomy

-قابلة للتعديل والإضافة حسب المُستجدات ✔

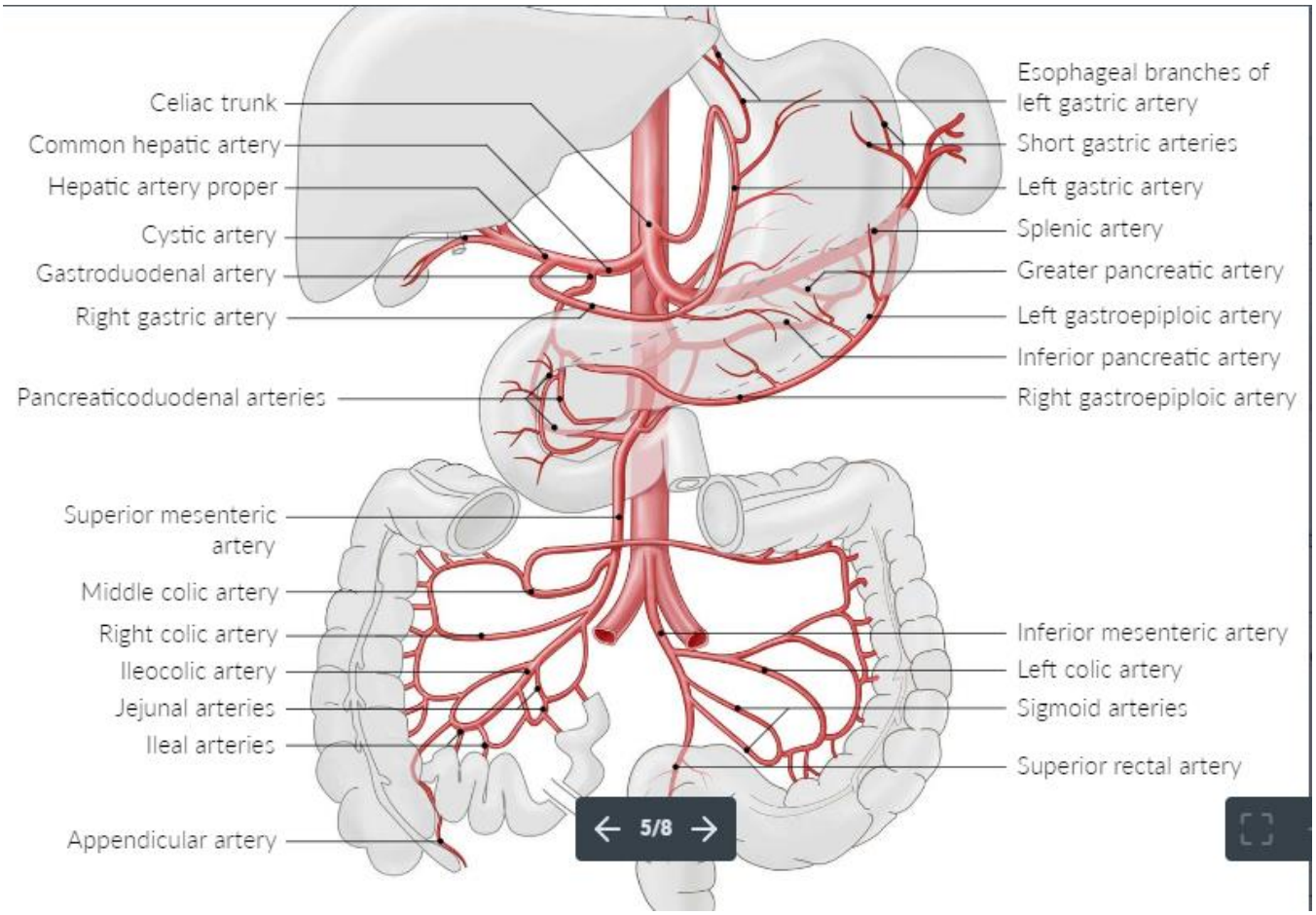
-وجب التنبيه أنَّها غير مطلوبة كاملة حفظًا للامتحان ، هي فقط لمُساعدتكم كمصدر واحد للاناتومي فيما يخص مواضيع ميجر الجراحة، المواضيع المهمة تمَّ تحديدها بلون مميز عند الفهرس ✔

-نُقدِّم هذا العمل صدقة جارية عن أرواح شُهدائنا في غزّة (معركة طوفانِ الأقصى-السابع من اكتوبر المجيد عام ٢٠٢٣) ، ونسألُ الله أن يتقبّله منا وأن يرزق الشهداء منزلة الفردوس الأعلى من الجنة ♡

-نشكر من قُمْنَ بإنجازِهِ بعد فضل الله وتوفيقه بإشراف لجنة الطب والجراحة:

إيناس الظاهر ، راما مُراد ، نسيبة المعايطة / سنة سادسة – دفعة وريد

❖Blood supply of the gastrointestinal tract:



1-Celiac trunk for foregut structures

2-Superior mesenteric artery for midgut structures

3-Inferior mesenteric artery for hindgut structures

-Arterial supply:

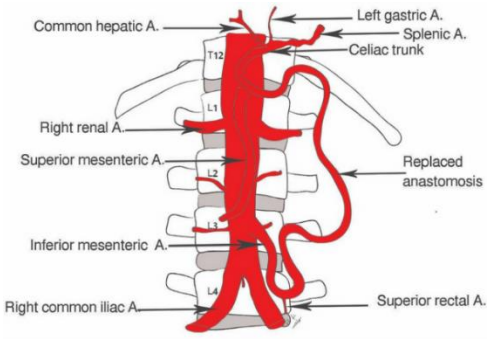
- **Most of the GIT is supplied by the anterior (unpaired) branches of the abdominal aorta**. In contrast, non-GI organs in the abdominal cavity are supplied by the posterior and/or lateral (paired) branches of the abdominal aorta.

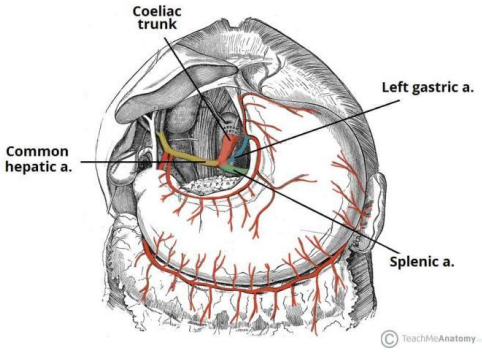
- **Exceptions:**
  - **Esophagus**: **supplied by the esophageal branches of the inferior thyroid artery, the thoracic aorta, and the left gastric artery.**
  - **Distal anal canal: supplied by the middle rectal artery and the inferior rectal artery** .
  - **Watershed zones**
    - **Splenic flexure**: supplied by the branches of both superior and inferior mesenteric arteries.
    - **Rectosigmoid junction:** supplied by the superior rectal artery and last sigmoid branch of the inferior mesenteric artery.

1-celiac trunk:

The coeliac trunk is a major artery of the abdomen. It arises from the abdominal aorta, and supplies many of the gastrointestinal viscera.

The coeliac trunk is the second branch of the abdominal aorta (the first branches are the paired inferior phrenic arteries). It arises from the anterior aspect of the aorta, at the aortic hiatus of the diaphragm (T12 level).





Major Branches

-After emerging from the aorta, the coeliac trunk extends approximately 1cm before dividing into three major branches:

left gastric, splenic and common hepatic arteries.

-Of these branches, two go left and one goes to the right-hand side. Collectively, **they are the major arterial supply to the stomach, spleen, liver, gall bladder, abdominal oesophagus, pancreas and duodenum. (foregut structures)**

1-left gastric artery

-The left gastric artery is the smallest of the three branches -continuing anteriorly along the lesser curvature of the stomach. Here, it anastomoses with the right gastric artery.

2-splenic artery

In addition to supplying the spleen, the splenic artery also gives rise to several important vessels:

- **Left gastroepiploic:** supplies the greater curvature of the stomach. Anastomoses with the right gastroepiploic artery.
- **Short gastrics:** 5-7 small branches supplying the fundus of the stomach.
- **Pancreatic branches:** supply the body and tail of the pancreas.

3-common hepatic artery:

The common hepatic artery is the sole arterial supply to the liver and the only branch of the coeliac artery to pass to the right.

As it travels past the superior aspect of the duodenum,

it divides into its two terminal branches – **the proper hepatic and gastroduodenal arteries**. Each of these arteries has multiple branches and variation in the arrangement of these branches is common.

Proper Hepatic

The proper hepatic artery ascends through the lesser omentum towards the liver. It gives rise to:

- **Right gastric:** supplies the pylorus and lesser curvature of the stomach.
- **Right and left hepatic:** divide inferior to the porta hepatis and supply their respective lobes of the liver.
- **Cystic:** branch of the right hepatic artery – supplies the gall bladder.

Gastroduodenal

The gastroduodenal artery descends posterior to the superior portion of the duodenum. Its branches are:

- **Right gastroepiploic:** supplies the greater curvature of the stomach. Found between the layers of the greater omentum, which it also supplies.
- **Superior pancreaticoduodenal:** divides into an anterior and posterior branch, which supplies the head of the pancreas

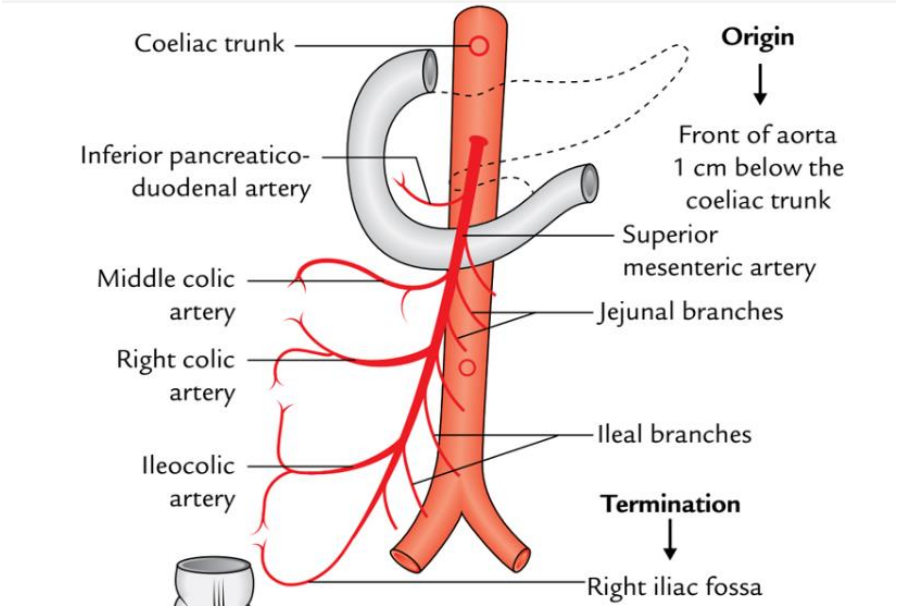
2-superior mesenteric artery:

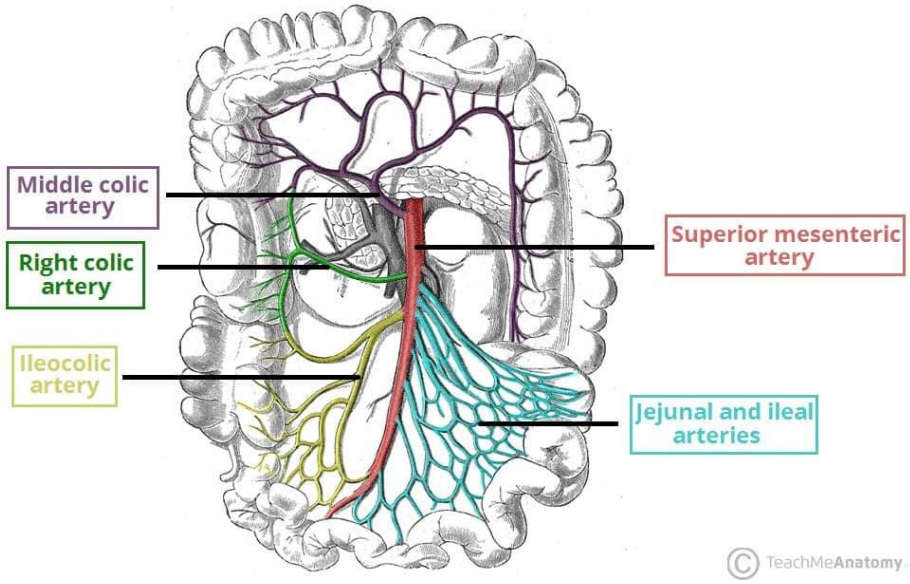
-The superior mesenteric artery (SMA) is a major artery of the abdomen. It arises from the abdominal aorta, and supplies arterial blood to the organs of the **midgut** – which spans from the major duodenal papilla (of the duodenum) to the proximal 2/3 of the transverse colon.

-The superior mesenteric artery is the second of the three major anterior branches of the abdominal aorta (the other two are the coeliac trunk and inferior mesenteric artery). It arises anteriorly from the abdominal aorta at the level of the **L1 vertebrae**, immediately inferior to the origin of the coeliac trunk.

-After arising from the abdominal aorta, the superior mesenteric artery descends down the posterior aspect of the abdomen. At this point, it has several important anatomical relations:

- **Anterior to the SMA** – pyloric part of the stomach, splenic vein and neck of the pancreas.
- **Posterior to the SMA** – left renal vein, uncinate process of the pancreas and inferior part of the duodenum.
    - The uncinate process is the only part of the pancreas that *hooks* around the back of the SMA.





Major Branches

1-Inferior Pancreaticoduodenal Artery

2-Jejunal and Ileal Arteries

3-Middle and Right Colic Arteries

The right and middle colic arteries arise from the right side of the superior mesenteric artery to supply the colon:

- **Middle colic artery** – supplies the transverse colon.
- **Right colic artery** – supplies the ascending colon.

4-Ileocolic Artery

The ileocolic artery is the final major branch of the superior mesenteric artery. It passes inferiorly and to the right, **giving rise to branches to the ascending colon, appendix, cecum, and ileum**. **In cases of appendectomy, the appendicular artery is ligated.**

Clinical Relevance: Occlusion of the Superior Mesenteric Artery

There are a number of causes of superior mesenteric artery occlusion, including thrombosis, embolism, abdominal aortic aneurysm and aortic dissection.

Often acute, occlusion of the SMA restricts blood flow to the midgut, resulting in **intestinal ischaemia**. It is more common in the elderly, and most usually presents with abdominal pain. The most useful investigation in this scenario is CT scan of the abdomen.

Treatment is surgical.

3-inferior mesenteric artery:

-The inferior mesenteric artery (IMA) is a major branch of the abdominal aorta. **It supplies arterial blood to the organs of the hindgut – the distal 1/3 of the transverse colon, splenic flexure, descending colon, sigmoid colon and rectum**.

-The inferior mesenteric artery is the last of the three major anterior branches of the abdominal aorta (the other two are the coeliac trunk and superior mesenteric artery). It arises at **L3**, near the inferior border of the duodenum, 3-4 cm above where the aorta bifurcates into the **common iliac arteries**.

As the artery arises from the aorta, it descends anteriorly to its parent vessel, before moving to the left side. It is a **retroperitoneal** structure – situated behind the peritoneum.

Major Branches

1-Left Colic Artery

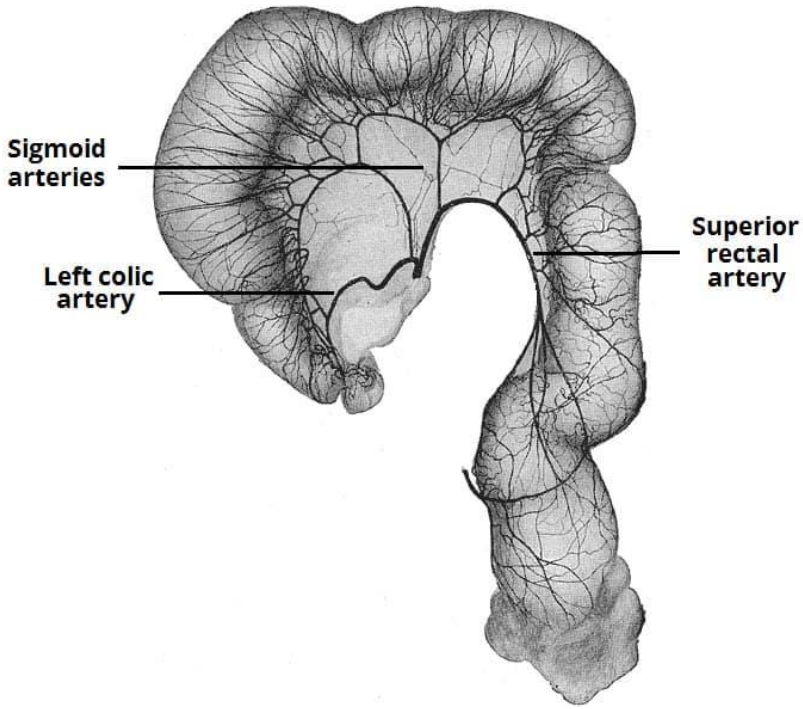
2-Sigmoid Arteries

The sigmoid arteries supply the descending colon and the sigmoid colon. There are typically 2-4 branches, with the uppermost branch termed the **superior sigmoid artery**. They run inferiorly, obliquely and to the left, crossing over the **psoas major**, left **ureter** and **left internal spermatic vessels.**

3-Superior Rectal Artery

The superior rectal artery is a continuation of the inferior mesenteric artery, supplying the rectum. It descends into the pelvis, crossing the left common iliac artery and vein.

At the S3 vertebral level, the artery divides into two terminal branches – one supplying each side of the rectum. Within the walls of the rectum, smaller divisions of these branches eventually communicate with the **middle** and **inferior rectal arteries**.

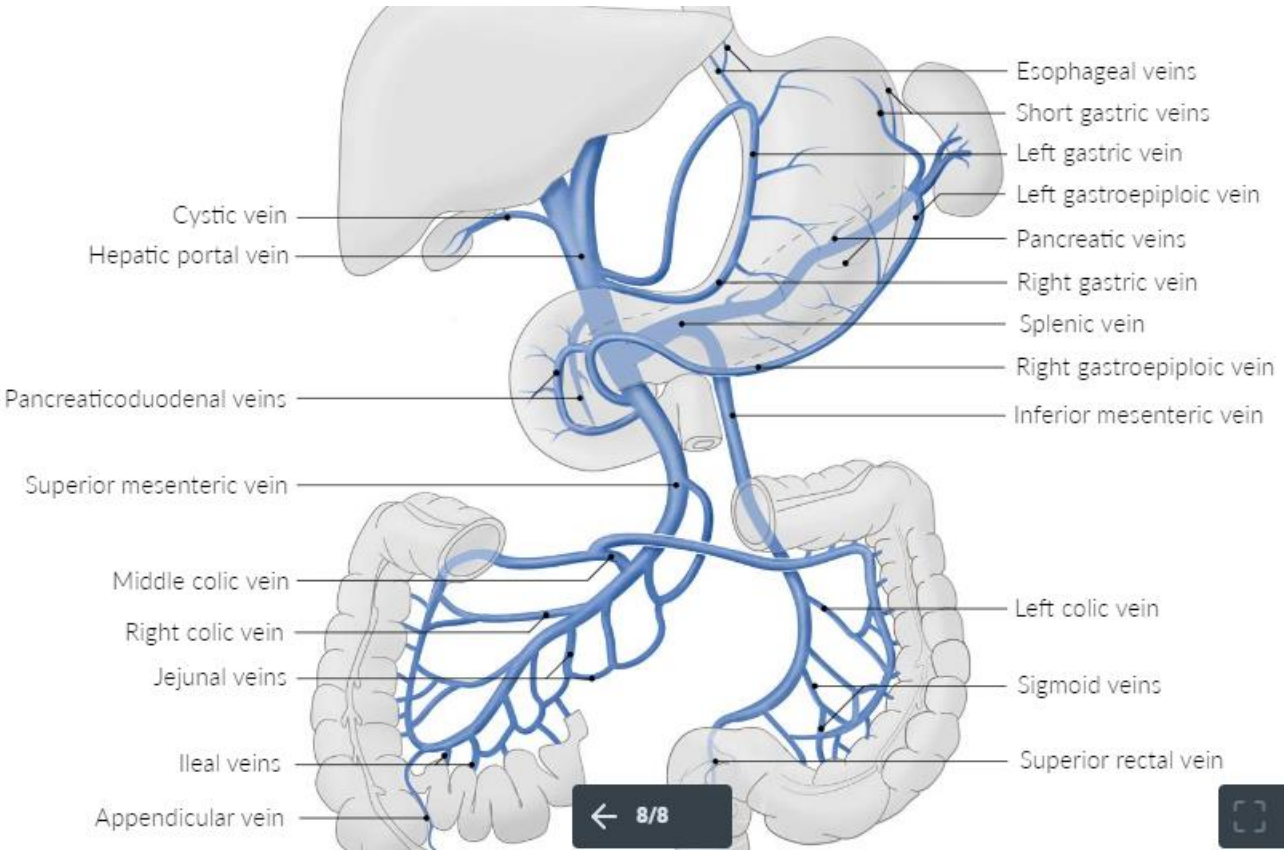


❖Venous drainage:

-The veins of most of the gastrointestinal tract drain directly or indirectly into the portal vein.

-Exceptions:

- **Esophagus**: drains into the inferior thyroid vein, the azygos vein, hemiazygos vein, and the left gastric vein
- **Distal anal canal (below the pectinate line):** drains into the inferior vena cava

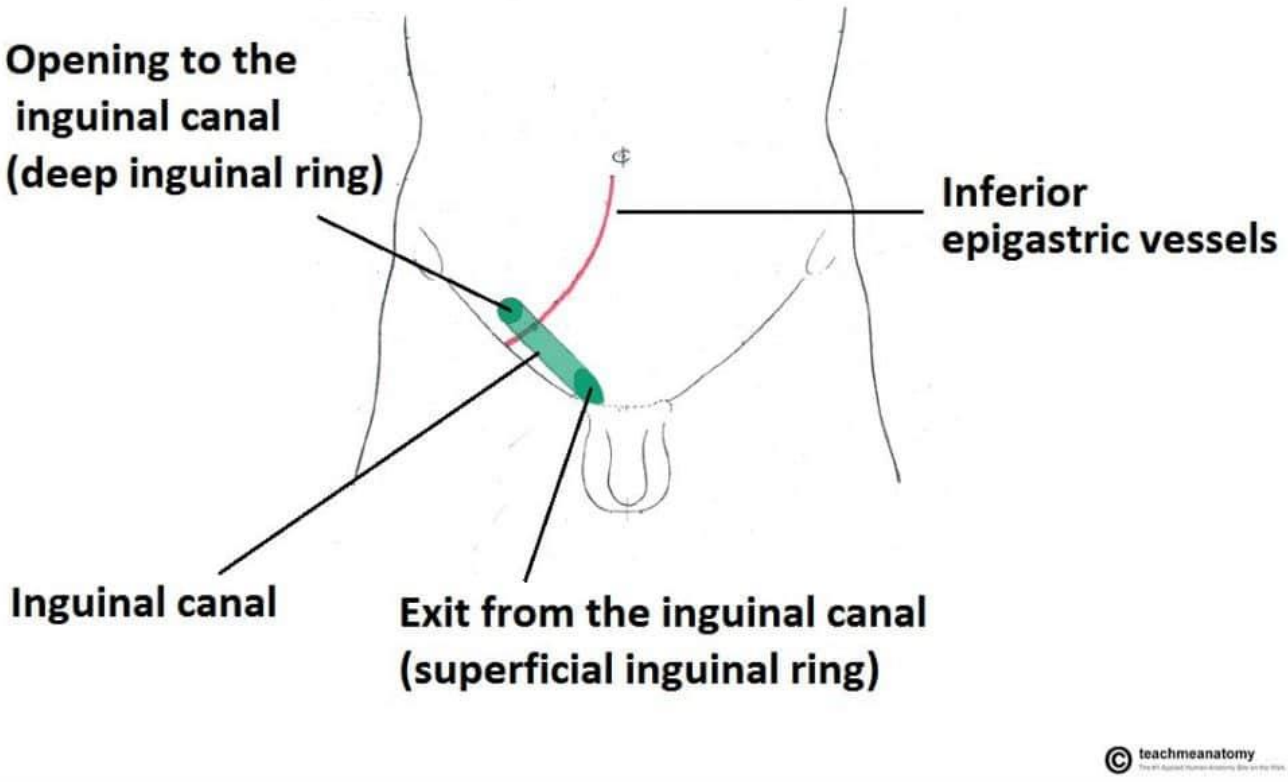


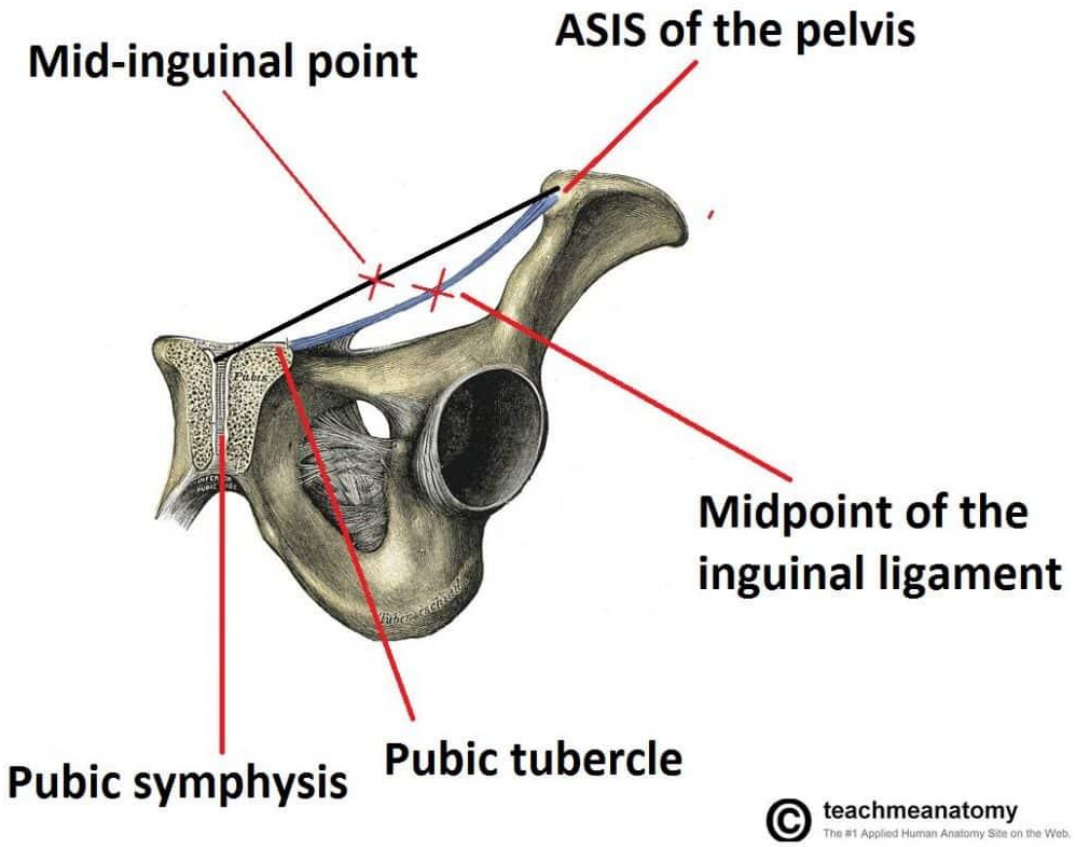
❖ Inguinal canal:

-The **inguinal canal** is a short passage that extends inferiorly and medially through the inferior part of the abdominal wall. It is superior and parallel to the inguinal ligament.

-The canal serves as a pathway by which structures can pass from the abdominal wall to the external genitalia. It is of clinical importance as a **potential weakness in the abdominal wall, and thus a common site of herniation.**

-In the embryological stage, the canal is flanked by an out-pocketing of the peritoneum (processus vaginalis) and the abdominal musculature.





Inguinal Point and Midpoint of the Inguinal Ligament

These two terms are mentioned frequently in this article, and are often (mistakenly) used interchangeably:

- **Mid-inguinal point – halfway between the pubic symphysis and the anterior superior iliac spine. The femoral pulse can be palpated here.**

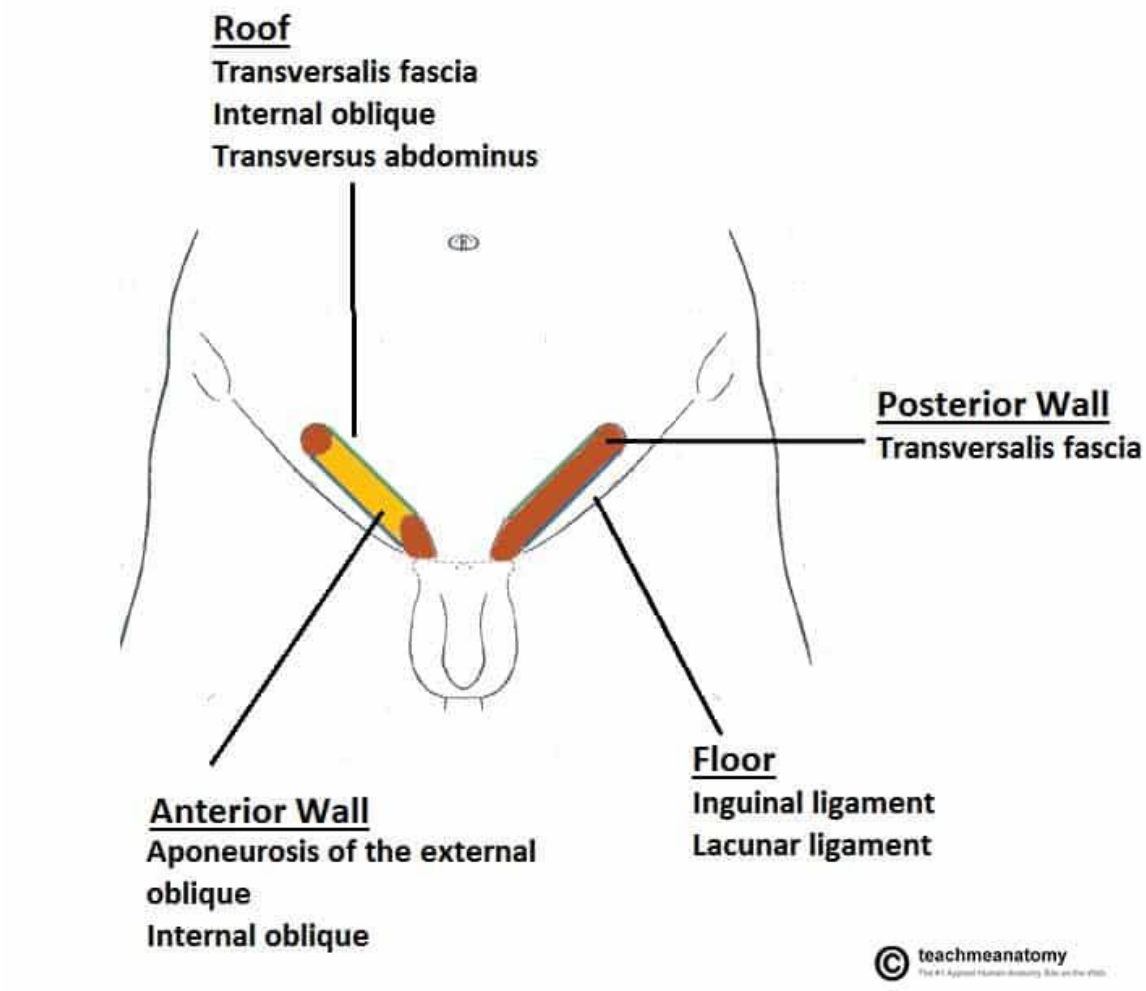
- **Midpoint of the inguinal ligament – halfway between the pubic tubercle and the anterior superior iliac spine (the two attachments of the inguinal ligament). The opening to the inguinal canal is located just above this point.**

Boundaries:

-The inguinal canal is bordered by anterior, posterior, superior (roof) and inferior (floor) walls. It has two **openings** – the superficial and deep rings.

Walls:

- **Anterior wall** – aponeurosis of the external oblique, reinforced by the internal oblique muscle laterally.
- **Posterior wall** – transversalis fascia.
- **Roof** – transversalis fascia, internal oblique, and transversus abdominis.
- **Floor** – inguinal ligament (a 'rolled up' portion of the external oblique aponeurosis), thickened medially by the lacunar ligament.



Rings:

-The two openings to the inguinal canal are known as rings. There are two rings – deep (internal) and superficial (external):

1-Deep (internal) ring:

- Marks the internal opening of the inguinal canal
- **Found above the midpoint of the inguinal ligament (lateral to the epigastric vessels).**
- **The ring is created by the transversalis fascia, which invaginates to form a covering of the contents of the inguinal canal.**

2-Superficial (external) ring:

- Marks the external end of the inguinal canal
- Lies just superior to the pubic tubercle.
- **It is a triangle shaped opening, formed by the invagination of the external oblique, which forms another covering of the inguinal canal contents.**
- It contains intercrural fibers, which run perpendicular to the aponeurosis of the external oblique and prevent the ring from widening.

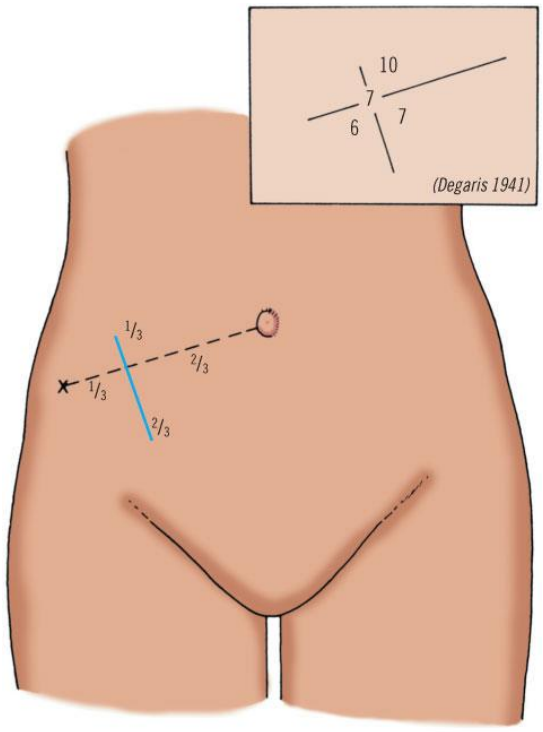
Structures traverse the Canal (content):

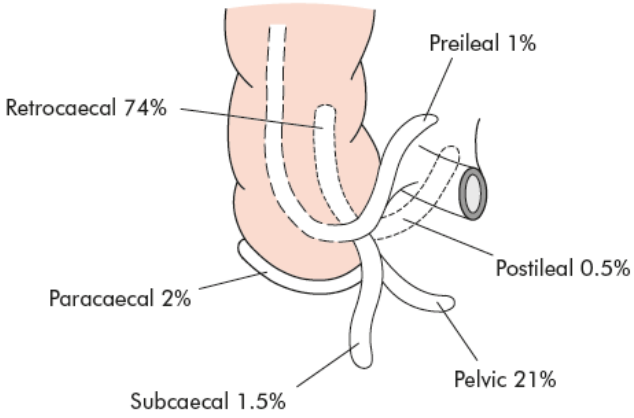
- **Spermatic cord** (biological males only) – contains neurovascular and reproductive structures that supply and drain the testes.
- **Round ligament** (biological females only) – originates from the uterine horn and travels through the inguinal canal to attach at the labia majora.
- **Ilioinguinal nerve** – contributes towards the sensory innervation of the genitalia
  - Note: only travels through *part* of the inguinal canal, exiting via the superficial inguinal ring (it does not pass through the deep inguinal ring)
  - This is the nerve most at risk of damage during an inguinal hernia repair.
- **Genital branch of the genitofemoral nerve** – supplies the cremaster muscle and anterior scrotal skin in males, and the skin of the mons pubis and labia majora in females.

Common question in clinical rounds (contents of inguinal canal in males?)

The spermatic cord crosses the inguinal canal,
and it contains 3 arteries, 3 nerves, 3 fasciae, 3 other things:
3 arteries: testicular, deferential, cremasteric
3 nerves: genital branch of the genitofemoral, cremasteric nerve, sympathetic nerve fibers
3 fasciae: external spermatic fascia, cremasteric fascia, internal spermatic fascia
3 other things: ductus deferens, pampiniform plexus, lymphatic vessels

❖Appendix:





McBurney's point:

Point one third from the anterior superior iliac spine to the umbilicus (often the point of maximal tenderness)

-What vessel provides blood supply to the appendix?

Appendiceal artery—branch of the ileocolic artery

-Appendix role : 1- part of immunity 2- stabilize the ureter

-Name the mesentery of the appendix:

Mesoappendix (contains the appendiceal artery)

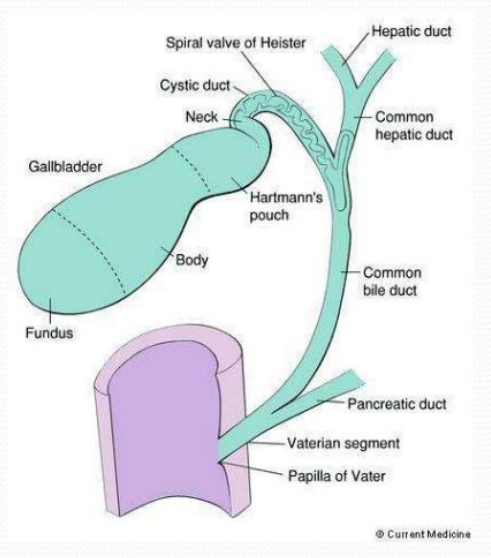
-How can the appendix be located if the cecum has been identified?

Follow the teniae coli down to the appendix; the teniae converge on the appendix

❖Gallbladder:

the anatomy of gallbladder

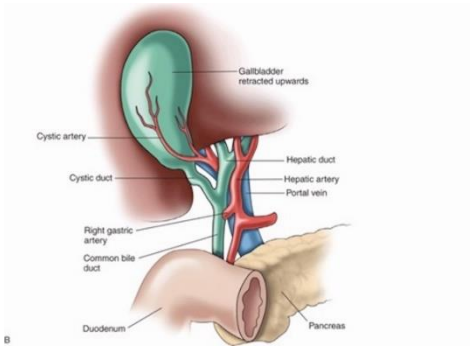
Its pear-shaped sac (7 to 10 cm long) with average capacity of 30 to 50 mL((When obstructed up to 300 ml))

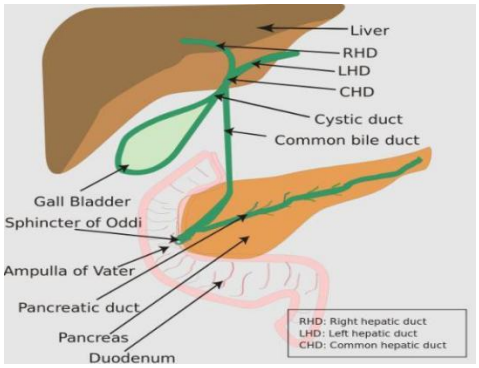


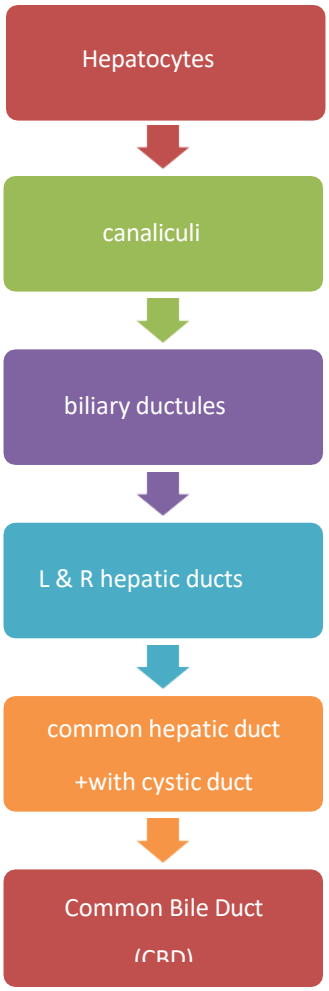
Divided into:

Neck: (has a small pouch called Hartmann's pouch. This is the location of most of the pathology)

Body , Fundus







-The left HD is longer than the right.

-CHD sits close to their emergence from the liver.

-CHD 1 to 4 cm in length and has a diameter of approximately 4 mm.

-It lies in front of the portal vein and to the right of the hepatic artery.

-CHD is joined at an acute angle by the cystic duct to form the common bile duct.

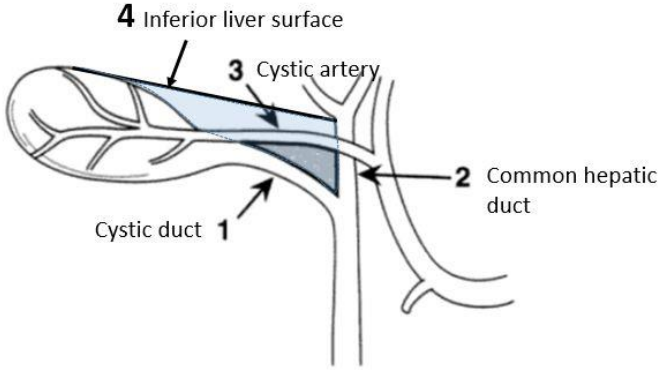
• Hepatobiliary triangle:

-An anatomical space formed by the common hepatic duct, the cystic duct, and the inferior border of the liver

-Contains the cystic artery and the cystic lymph node (Lund's node)

-During cholecystectomy, the hepatobiliary triangle must be carefully identified to prevent damage to the cystic artery and extrahepatic biliary system.

• Calot triangle: **an anatomical space formed by the common hepatic duct, the cystic duct, and the cystic artery**



Cysto-hepatic triangle= (Budde-Rocko triangle) =calot triangle

-What is the triangle of calot?

anatomical space formed by the common hepatic duct, the cystic duct, and the cystic artery (3Cs)

-where is the fundus of the gallbladder?

At the end of gallbladder

-What is hartmanns pouch?

Gallbladder infundibulum

-What is the artery susceptible to be injured during cholecystectomy?

Right hepatic artery, because of its proximity to the cystic artery and Calot's triangle

-What is sphincter of oddi?

is the muscular valve surrounding the exit of the bile duct and pancreatic duct into the duodenum

NOTE:

usually a branch of the right hepatic artery (>90% of the time)
course of the cystic artery may vary, but it nearly always is found within the hepatocystic triangle.
it divides into anterior and posterior divisions

NERVE SUPPLY:

Parasympatheic fibers from the left (anterior) trunk of the vagus nerve.
Sympathetic fibers from the T7-T10 nerves coursing through the splanchnic and celiac ganglions.

❖ Esophagus

- ❖ Derived from the embryonic foregut
- ❖ Tube that connects the pharynx (at the level of C6) to the stomach (at the level of T11)
- ❖ Length: ~ 25 cm
- ❖ Crosses the diaphragm at T10 through the esophageal hiatus
  - The thoracic esophagus is extraperitoneal.
  - The abdominal part is intraperitoneal.

	Arteries	Veins	Lymphatics
Cervical portion	• Esophageal branches of inferior thyroid artery	• Inferior thyroid vein	• Mediastinal lymph nodes
Thoracic portion	• Esophageal branches of thoracic aorta	• Azygos and hemiazygos veins	
Abdominal portion	• Esophageal branches of left gastric arteries	• Left gastric vein (which drains into the portal circulation)	

Innervation	
Sensation	• Vagus nerve
Sympathetic	• Cervical and thoracic sympathetic trunk: decrease peristalsis and glandular activity; transmit pain

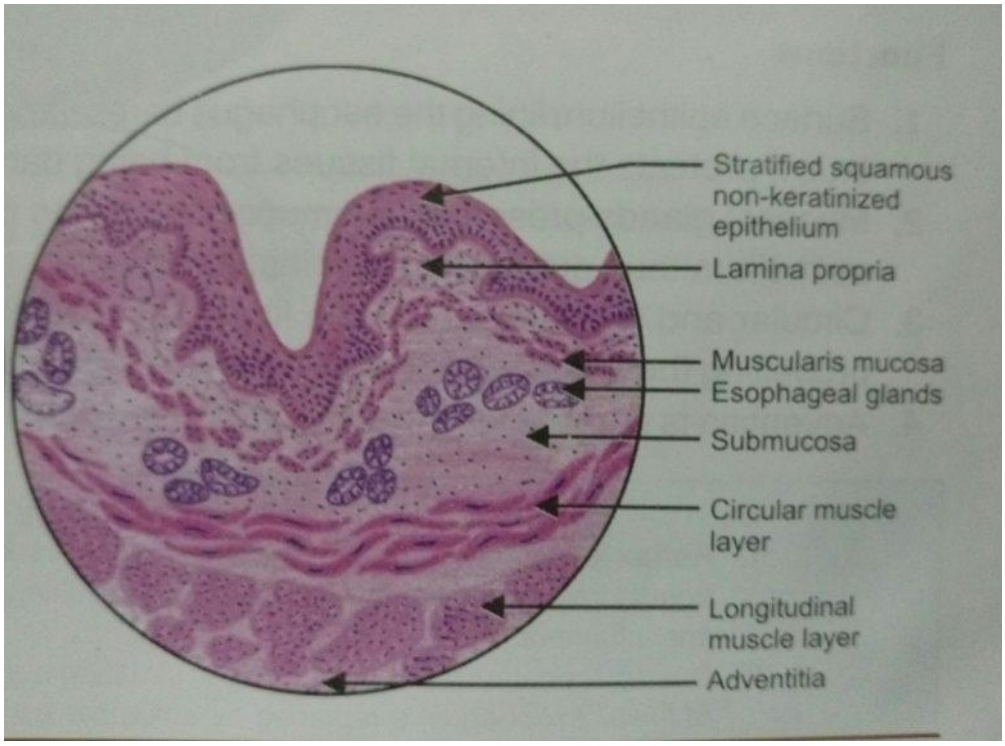
Parasympathetic	• Vagus nerve: innervates esophageal muscles and glands
	  ◦ Striated muscle (mostly in upper ⅓ of esophagus): recurrent laryngeal branches of the vagus nerve (descend from the nucleus ambiguus)
	  ◦ Smooth muscle and lower esophageal sphincter: parasympathetic fibers (descend from the dorsal motor nucleus of vagus)

Enteric nervous system	• Auerbach plexus and Meissner plexus

❖ Microscopic anatomy:

❖ **Four concentric layers:**

- **Mucosal (innermost)**
  - Nonkeratinizing stratified squamous epithelium
  - Transitions to columnar epithelium at the gastroesophageal junction
- **Submucosal**
  - Contains blood vessels, **Meissner's plexus**, and glandular epithelium
- **Muscular**
  - Contains inner circular and outer longitudinal muscle fibers. The **Auerbach's plexus** lies in between the two layers.
  - Proximal ⅓ → mostly striated muscle
  - Distal ⅔ → mostly smooth muscle
- **Adventitia (outermost)**
  - Consists of dense connective tissue and elastic fibers



❖ Stomach

❖ Characteristics

- Hollow, muscular organ
- First intra-abdominal part of the gastrointestinal tract, situated between the esophagus (proximally) and the duodenum (distally)
- Divided into the cardia, gastric fundus, body (stomach), and pylorus
- The stomach is a derivative of the primitive foregut.

❖ Location

- LUQ of the abdomen
- Abdominal regions: epigastric, left hypochondriac, and umbilical
- **Anterior to the stomach**
  - **Anterior abdominal wall**
  - **Left lobe of the liver**
  - **Greater omentum**
  - **Diaphragm**
- **Posterior to the stomach**
  - **Spleen**
  - **Tail of the pancreas**
  - **Left kidney**
  - **Left adrenal gland**
  - **Transverse colon**
  - **Transverse mesocolon and lesser sac**

❖ Anatomical parts:

- **Sections of the stomach**
  - Cardia: the part of the stomach that lies immediately distal to the gastroesophageal sphincter
  - Gastric fundus: the dome-shaped region of the stomach just lateral to the cardia
  - Body (stomach): the main portion of the stomach that lies between the fundus and the pylorus

- Pylorus: the terminal conical narrowing of the stomach that can be further subdivided into the proximal antrum and the distal pyloric canal

- **Curvatures of the stomach**
  - Lesser curvature: the medial concave border of the stomach
  - Greater curvature: the lateral convex border of the stomach
- **Sphincters of the stomach**
  - Gastroesophageal sphincter (lower esophageal sphincter)
    - Circular muscle located at the junction between the gastric cardia and esophagus (Th11)
    - Prevents reflux of gastric contents into the esophagus
  - Pyloric sphincter
    - A muscular ring located in the pyloric canal
    - Controls the movement of gastric contents into the duodenum

The antrum and lower lesser curvature are the most common sites for peptic stomach ulcers.

❖ Peritoneal attachments:

The stomach is **an intraperitoneal organ**.

- Omentum: extends from stomach (and proximal duodenum) to other abdominal organs
  - Greater omentum: from greater curvature and covers intestines
  - Lesser omentum: from lesser curvature to liver
- Peritoneal ligaments of the stomach:
  - Gastrohepatic ligament
  - Gastrocolic ligament
  - Gastrosplenic ligament

Arteries of the stomach

		Structure	Origin	Important features
Lesser curvature	Superior part	• Left gastric artery	• Celiac trunk	• Contained within the gastrohepatic ligament • Anastomoses along the lesser curvature with the right gastric artery
	Inferior part	• Right gastric artery	• Proper hepatic artery (a continuation of the common hepatic artery, a branch of the celiac trunk)	• Contained within the gastrohepatic ligament • Anastomoses along the lesser curvature with the left gastric artery
Greater curvature	Superior part	• **Left gastroepiploic artery** (also known as the left gastro-omental artery)	• Splenic artery (a branch of the celiac trunk)	• Contained within the gastrosplenic ligament and gastrocolic ligament • Anastomoses along the greater curvature with the right gastroepiploic artery
	Inferior part	• **Right gastroepiploic artery** (also known as the right gastro-omental artery)	• Gastroduodenal artery (a branch of the common hepatic artery)	• Contained within the gastrocolic ligament • Anastomoses along the greater curvature with the left gastroepiploic artery
Fundus		• **Short gastric arteries**	• Splenic artery	• Contained within the gastrosplenic ligament
Posterior gastric wall		• **Posterior gastric artery**	• Splenic artery	

Specialized cells of the gastric glands		
Region	**Cell type**	**Secretory product or function**
Fundus and body	• Chief cell ◦ Pyramid-shaped cells with basally located nuclei and basophilic cytoplasm ◦ Contain pepsinogen granules ◦ Typically located at the bases of the gastric glands	• Pepsinogen
	• Parietal cell ◦ Large eosinophilic cells with a circular nucleus (fried egg appearance) ◦ Typically located in the middle of the gastric glands	• HCl • Intrinsic factor
	• Enterochromaffin-like cell (ECL cell) ◦ A type of neuroendocrine cell ◦ Adjacent to parietal cells	• Histamine
	• P/D1 cell ◦ A type of enteroendocrine cell ◦ Most abundant in glands of the gastric fundus	• Ghrelin [2]
Pylorus and antrum	• D cell	• Somatostatin
	• G cell	• Gastrin

❖Small intestine

- ❖ Middle portion of the gastrointestinal tract situated between the pylorus proximally and the ileocecal junction distally
- ❖ **Length (adult): ~ 6.5 m (21 ft)**
- ❖ Subdivisions: duodenum, jejunum, and ileum

❖ Embryology:

- ❖ **Foregut: duodenum proximal to the major duodenal papilla**
- ❖ **Midgut: distal duodenum, jejunum, and ileum**

❖ Anatomical subdivisions:

1. Duodenum

- First and widest part of the small intestine
- C-shaped: surrounds the head of the pancreas

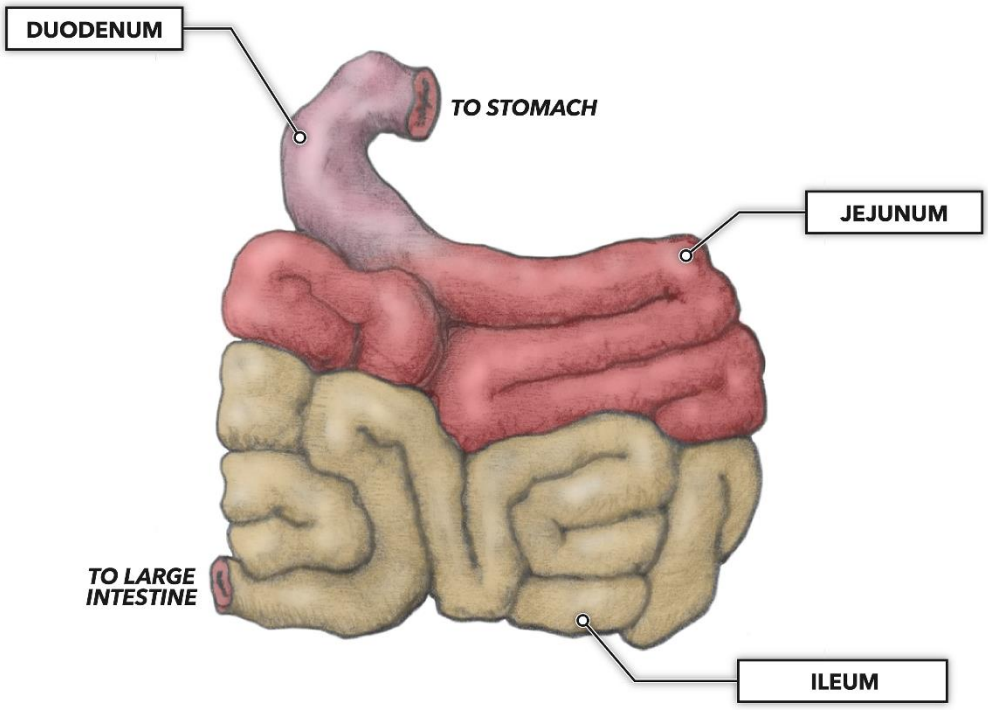
- Located mainly within the epigastric and umbilical regions of the abdomen
- **Only the 1st part of the duodenum is intraperitoneal. The 2nd–4th parts are retroperitoneal**

2. Jejunum

- Second part of the small intestine
- Located mainly in the LUQ of the abdomen
- **Intraperitoneal**

3. Ileum

- Final **and narrowest part of the small intestine**
- Located mainly in the RLQ of the abdomen
- **Intraperitoneal**
- Separated from the large intestine at the ileocecal junction by the ileocecal valve:
  - Muscular sphincter that regulates the passage of fluid and nutrients from the ileum into the cecum and prohibits reflux
  - Provides a mechanical barrier to bacterial migration into the small intestine



Parts of the duodenum				
	Peritoneal relations	Embryological origin	Important anatomy	Clinical significance
First part of the duodenum (superior) (duodenal bulb)	• Intraperitoneal	• Foregut	• The gastroduodenal artery and common bile duct lie posterior to the duodenal bulb.	• Most common site of **duodenal ulcers** • A posterior duodenal ulcer may erode the gastroduodenal artery and cause an upper GI bleed. • Attached to the liver via the hepatoduodenal ligament
Second part of the duodenum (descending)	• Retroperitoneal	• Proximal to the ampulla of Vater: foregut • Distal to the ampulla of Vater: midgut	• Contains: ◦ Ampulla of Vater ◦ Major duodenal papilla: protrusion of the ampulla of Vater into the duodenum ◦ Sphincter of Oddi ◦ Minor duodenal papilla: opening of the accessory pancreatic duct	• The major duodenal papilla is cannulated during ERCP. • Ampulla of Vater sphincterotomy is performed for impacted distal choledocholithiasis.
Third part of the duodenum (horizontal)			• Anterior relation: superior mesenteric vessels • Posterior relation: aorta	• SMA syndrome
4th (ascending) part		• Midgut	• Duodenojejunal flexure (DJ flexure) ◦ Junction between the ascending duodenum and the jejunum ◦ Located on the left side of the L2 vertebra • **Ligament of Treitz**: avascular peritoneal fold that fixes the DJ flexure to the posterior abdominal wall	• DJ flexure on the right side of the L2 vertebra indicates intestinal malrotation.

Vasculature, lymphatics, and innervation of the small intestine			
	Duodenum	**Jejunum**	**Ileum**

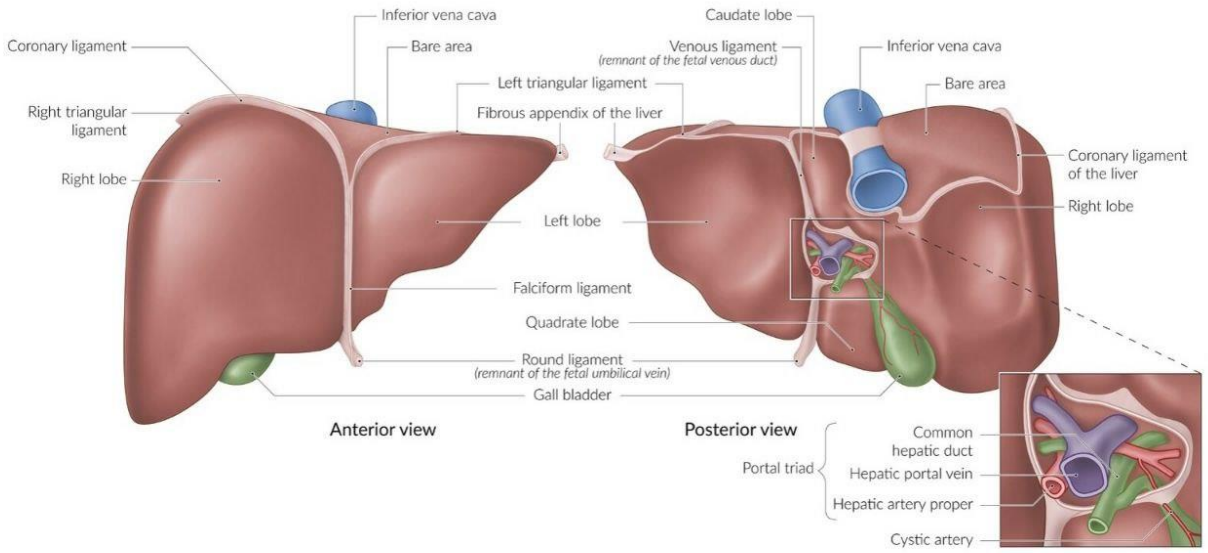
Arteries	• Proximal to the major duodenal papilla (**foregut derivatives**): branches of the **celiac trunk**
	  ◦ Gastroduodenal artery
	  ◦ Superior pancreaticoduodenal artery
	• Distal to the major duodenal papilla (**midgut derivatives**): branches of the **superior mesenteric artery** (inferior pancreaticoduodenal artery)
		• Jejunal branches of the superior mesenteric artery → intermesenteric arterial anastomoses → vasa recta (intestines)	• Ileal branches of the superior mesenteric artery → intermesenteric arterial anastomoses → vasa recta
			• Ileocolic artery supplies the distal ileum.

Veins	• Superior pancreaticoduodenal vein → portal vein • Inferior pancreaticoduodenal vein → SMV → portal vein	• SMV → portal vein	
Lymphatics	• Celiac and superior mesenteric nodes	• Superior mesenteric nodes	

Innervation	• Celiac plexus
	  ◦ Parasympathetic: vagus nerves
	  ◦ Sympathetic: greater and lesser splanchnic nerves
		• Superior mesenteric plexus
		  ◦ Parasympathetic: vagus nerves
		  ◦ Sympathetic: greater and lesser splanchnic nerves	

Specialized cells of the small intestine				
Cell		**Secretory product**	**Location and characteristics**	**Function**
Enterocytes		• None	• Simple columnar epithelium • Basal nuclei • Lining villi and crypts of Lieberkuhn • Most common cell type of the intestinal mucosa	• Absorb nutrients • Transport nutrients to the bloodstream
Enteroendocrine cells	**G cells**	• Gastrin	• Crypts of Lieberkuhn (lower half)	• See "Secretory and regulatory products of the gastrointestinal tract".
	D cells	• Somatostatin		
	I cells	• Cholecystokinin		
	S cells	• Secretin		
	K cells	• Gastric inhibitory polypeptide		
	Mo cells	• Motilin		
Paneth cells		• Lysozyme • Defensin • TNF-α	• Crypts of Lieberkuhn (base) • More common in jejunum and ileum • Contain acidophilic granules	• Lysozymes and defensins destroy bacteria. • TNF-α regulates the immune response to pathogens.
Goblet cells		• Mucous • Glycoproteins	• Villi • Crypts of Lieberkuhn • Most abundantly present in the small intestine	• Lubricates the GIT • Traps bacteria • Aids binding of immunoglobulins to pathogens
Stem cells		• None	• Crypts of Lieberkuhn (lower half)	• Proliferate and differentiate into the various cells of the small intestine • Repair mucosal injuries

❖ Liver



❖ **Largest gland in the body**

- ❖ **Weight: ~ 1.2–1.5 kg in adults**
- ❖ **Consists of four lobes:**
  - **Right (largest)**
  - **Left**
  - **Quadrate**
  - **Caudate**
- ❖ **Typically divided into 8 segments**
- ❖ **Surrounded by the hepatic capsule**
- ❖ **Porta hepatis structures**
  - **Common hepatic duct (leaving)**
  - **Hepatic artery proper (entering)**
  - **Hepatic portal vein (entering)**
  - **Hepatic nerve plexus and lymphatic vessels**
- ❖ Location: under the diaphragm in the right upper abdomen.
  - Extends from the fifth intercostal space to the right costal margin in the midclavicular line

Embryology

- Endoderm origin

- Derived from junction of foregut and midgut
- Ligamentum teres: formed from the obliterated umbilical vein

Ligaments

- **Falciform ligament**
  - Connects liver to abdominal wall
- **Hepatoduodenal ligament**
  - Connects liver to duodenum
  - Contains portal triad (proper hepatic artery, portal vein, common bile duct)
    - Clinical correlate: in cases of liver hemorrhage, temporary clamping of the hepatoduodenal ligament (Pringle maneuver) can help to achieve hemostasis
- **Gastrohepatic ligament**
  - Connects liver to lesser curvature of the stomach
  - Contains gastric arteries

Distention of the capsule results in well-localized, sharp pain, as seen in ascites, inflammation, or hepatic cancer.

❖

Vasculature of the liver	
Type of vessel	Vessels
Arteries	• Dual blood supply ◦ **Hepatic artery proper** (supplies 20–40% of blood): a branch of the common hepatic artery, which branches off the celiac trunk of the abdominal aorta ◦ **Portal vein** (supplies 60–80% of blood) ▪ Forms from the superior mesenteric vein (SMV) and splenic vein ▪ Collects blood from gastrointestinal tract, spleen, and pancreas ▪ Despite being deoxygenated, it still supplies the liver with about half its oxygen demands. ▪ Delivers nutrients and other metabolites
Veins	• Hepatic veins, which drain into the inferior vena cava
Lymphatics	• Celiac lymph node cluster

Innervation

- Glisson capsule and serosa: lower intercostal nerves
- Parenchyma: hepatic plexus

Liver function tests

Laboratory parameters of hepatocellular damage

Laboratory parameter		Physiological function	Characteristics	Common causes of elevation
Transaminases (aminotransferases)	Alanine aminotransferase (ALT)	• Enzyme involved in gluconeogenesis and the generation of urea	• Specific to the cytoplasm of hepatocytes	• All types of **hepatocyte damage** (see "AST/ALT ratio") • **Muscle damage** (esp. AST) • **Myocardial infarction** (esp. AST) • Significant elevation (> 1,000 U/L) ◦ Hepatotoxic drugs (e.g., acetaminophen) ◦ Some hepatitis subtypes (e.g., autoimmune, ischemic, or acute viral hepatitis)
	Aspartate aminotransferase (AST)	• Enzyme involved in amino acid metabolism	• Present in the liver, heart, muscle, and erythrocytes • In hepatocytes, AST is located in the mitochondria and cytoplasm.	
Glutamate dehydrogenase (GLDH)		• An enzyme involved in amino acid metabolism	• Only present in the mitochondria of hepatocytes • Marker for severe hepatocellular damage	• Severe hepatitis • Toxins (e.g., α-amanitin) • Hepatocellular carcinoma, liver metastases

❖ **AST/ALT ratio**

- **AST/ALT < 1 (AST < ALT)**
  - **Uncomplicated viral hepatitis**
  - **Minor fatty liver disease**
  - **Extrahepatic cholestasis**
- **AST/ALT ≥ 1 (AST > ALT)**
  - **Alcoholic hepatitis**
    - **Typically AST/ALT > 2**
    - **AST usually does not exceed 500 U/L in alcoholic hepatitis.**
  - **Fulminant, necrotic hepatitis**
  - **(Decompensated) cirrhosis: The AST/ALT ratio can increase as fibrosis advances.**
  - **Hepatocellular carcinoma, liver metastases**
  - **Muscle damage**
  - **Myocardial infarction**

Laboratory parameters of cholestasis

Laboratory parameter	Physiological function	Characteristics	Common causes of elevation
Alkaline phosphatase (ALP)	Enzyme that cleaves phosphate groups under alkaline conditions	• Isoenzymes found in numerous tissues, including liver, bones, placenta, and kidney	• **Cholestasis** (obstructive or nonobstructive) • Infiltrative diseases of the liver (e.g., malignancies or amyloidosis) • Increased **osteoblast** activity • Seminoma • Pregnancy (third trimester) • Chronic kidney disease
γ-Glutamyl transpeptidase (γ-GT, GGT) [19]	• Membrane-bound enzyme involved in glutathione metabolism and amino acid transport	• The most sensitive parameter for diseases of the liver and/or biliary tract • Usually the first liver enzyme to rise after bile duct obstruction • Used to confirm hepatic origin of elevated ALP levels	• **Cholestasis** (obstructive or nonobstructive) • **Alcohol use** • **Not elevated in bone disease** (in contrast to ALP)

	Indirect (unconjugated) bilirubin	• **Lipophilic** catabolite of heme
		• See "Bilirubin metabolism."
			• **Water-insoluble**	• Overproduction (extrahepatic) [20]
				  ◦ **Hemolysis**
				  ◦ Large hematomas
				  ◦ Ineffective erythropoiesis (e.g., in folate or iron deficiency)
				• Impaired uptake (prehepatic)
				  ◦ Congestive heart failure
				  ◦ Portosystemic shunts
				  ◦ Drugs (e.g., rifampin, probenecid)
				• Impaired conjugation (intrahepatic)
				  ◦ Crigler-Najjar syndrome types I and II
				  ◦ Gilbert syndrome
				  ◦ Neonates
				  ◦ Chronic hepatitis
				  ◦ Advanced cirrhosis
				  ◦ Hyperthyroidism
				  ◦ Ethinyl estradiol (e.g., in some combined oral contraceptives)

Indirect bilirubin is water-**in**soluble.

Bilirubin	**Direct (conjugated) bilirubin**	• In the liver, bilirubin is conjugated with **glucuronic acid**. • Excreted via bile • See "Bilirubin metabolism."	• **Water-soluble**	• **Cholestasis** (typically greater increase in obstructive cholestasis) ◦ Obstructive (extrahepatic) causes include: ▪ **Choledocholithiasis** ▪ Tumors (e.g., cholangiocarcinoma, pancreatic cancer) ▪ Primary sclerosing cholangitis ▪ Pancreatitis ▪ Strictures after invasive procedures ▪ Parasitic infections (e.g., *Ascaris lumbricoides*, liver flukes) ◦ Nonobstructive (intrahepatic) causes include: ▪ Hepatitis (viral, alcoholic, NASH) ▪ Primary biliary cholangitis ▪ Drugs (e.g., alkylated steroids, chlorpromazine) ▪ Sepsis ▪ Infiltrative diseases (e.g., amyloidosis, sarcoidosis, tuberculosis) ▪ Pregnancy • Dubin-Johnson syndrome • Rotor syndrome
5'-nucleotidase (5'-NT) [21]		• Membrane-bound enzyme that hydrolyzes a nucleotide into a nucleoside and phosphate	• Used to confirm hepatobiliary origin of elevated ALP levels	• Cholestasis (esp. obstructive) • Infiltrative diseases of the liver (e.g., malignancy, amyloidosis)

❖ Pancreas

❖ **Origin**: derived from the foregut (endoderm)

❖ **Location**

○ **Secondary retroperitoneal organ**

❖ **Function**

○ Endocrine : Composed of islets of Langerhans embedded within the exocrine pancreas

○ Islet cell types are dispersed throughout the pancreas.

- Alpha cells produce glucagon.
- Beta cells produce insulin.
- Delta cells produce somatostatin.
- Epsilon cells produce ghrelin.

○ Exocrine > 90% of the pancreas

- Produces digestive enzymes that aid the absorption of macronutrients
- Produces bicarbonate, which neutralizes chyme

❖ Anatomical subdivisions of the pancreas [1][2]

- **Head**
  - Contains the pancreatic duct and distal common bile duct
- **Tail**
  - Lies in the splenorenal ligament
  - The distal segment is **intraperitoneal**.

❖ **Tumors in the pancreatic head often cause bile duct obstruction and can manifest with painless jaundice (Courvoisier sign).**

❖ **Gallstones that block the ampulla of Vater can result in both pancreatitis and cholangitis (double duct sign).**

> ❖ **The uncinate process is posterior to the superior mesenteric vessels. The head, body, and tail of the pancreas lie anterior to the superior mesenteric vessels.**

❖ Pancreatic ducts [1][2]

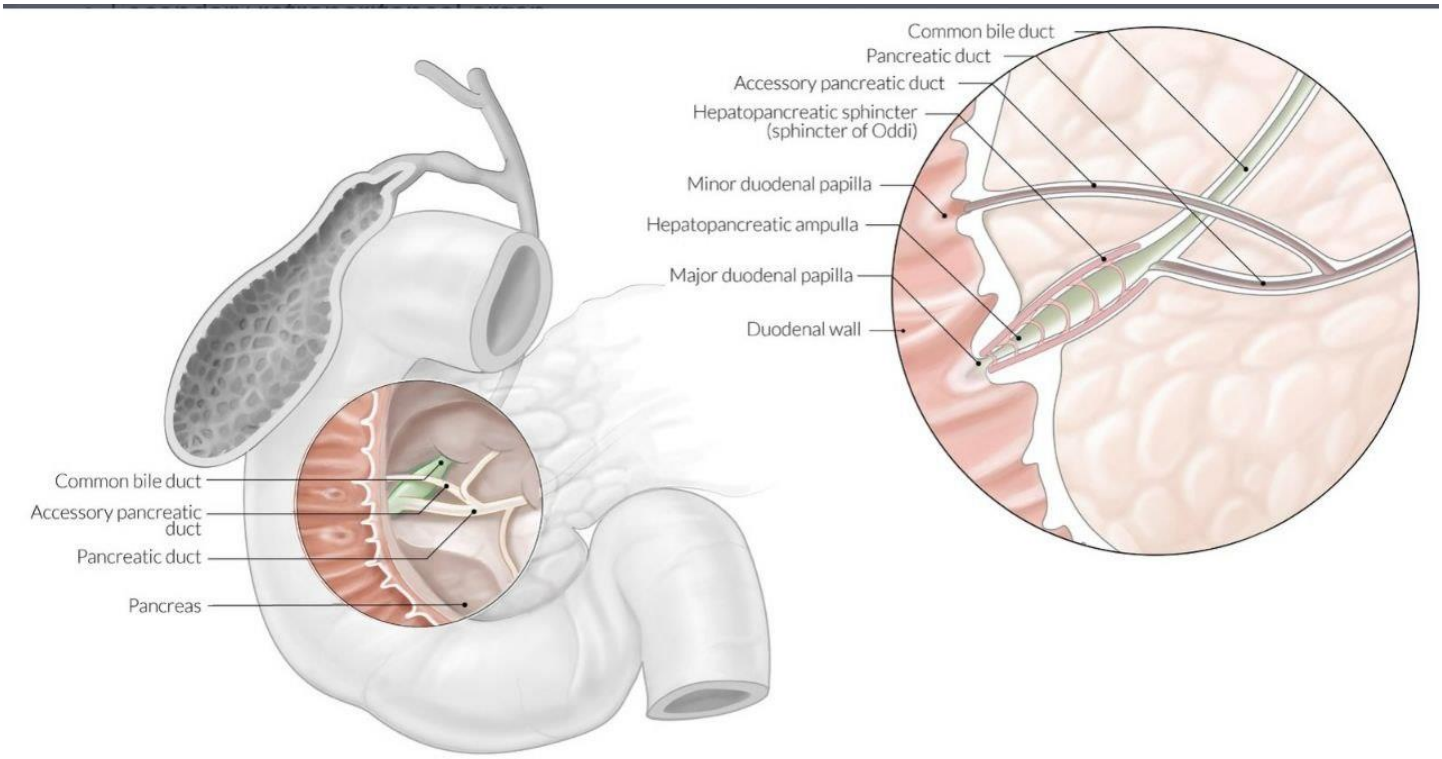
- **Pancreatic duct (duct of Wirsung):** extends from the tail to the head of the pancreas
  - Joins with the common bile duct → together they form the hepatopancreatic ampulla (ampulla of Vater) → empties into the major duodenal papilla
  - Hepatopancreatic sphincter (sphincter of Oddi): controls the secretion of bile and pancreatic fluid into the duodenum
- **Accessory pancreatic duct (duct of Santorini):** begins in the head and drains the pancreatic head and body → empties at the minor duodenal papilla

> ❖ **Most pancreatic malignancies are adenocarcinomas that originate in the ductal epithelium.**

❖ Vasculature, lymphatics, and innervation of the pancreas [1][2]

- **Arteries**
  - Head and neck
    - Superior pancreaticoduodenal branches (from the gastroduodenal artery)
    - Inferior pancreaticoduodenal branches (from the superior mesenteric artery)
  - Body and tail: branches of the splenic artery (itself a branch of the celiac trunk)

- **Veins**
  - Head and neck: pancreatic veins → superior mesenteric vein → portal vein
  - Body and tail: pancreatic veins → splenic vein → portal vein
- **Lymphatics**: celiac, superior mesenteric, and splenic lymph nodes → paraaortic lymph nodes
- **Innervation**: celiac ganglia
  - Sympathetic fibers from T6–12
  - Parasympathetic fibers from the vagus nerve



✓ Pancreas function tests

Overview of pancreatic parameters

Laboratory parameter		Physiological function	Characteristics	Common causes of elevation	Common causes of reduction
Pancreatic lipase		• Enzyme involved in the digestion of **lipids** in the small intestine	• Pancreas-specific	• **Acute pancreatitis** • Renal failure	• Exocrine pancreatic insufficiency
Amylase		• Enzyme involved in the digestion of **carbohydrates** in the small intestine	• Several isoenzymes are found in many different tissues (not specific to pancreas). • Mainly produced by the **pancreas** and **salivary glands**	• **Acute pancreatitis** • Diseases affecting the **salivary glands**, e.g.: ◦ Parotitis ◦ Bulimia nervosa, leading to parotid gland hypertrophy [22] • Renal failure	• Exocrine pancreatic insufficiency
Elastase	**In serum**	• Enzyme that breaks down **elastin**	• Pancreas-specific • Most common test for assessing **exocrine pancreas function**	• Acute pancreatitis	• Usually no clinical relevance
	In stool			• Usually no clinical relevance	• **Exocrine pancreatic insufficiency** ◦ Chronic pancreatitis ◦ Cystic fibrosis

❖Spleen

○ Location:

- Left upper quadrant (LUQ) of the abdomen
- **Protected by the left 9th to 11th ribs**
- Neighboring structures of the spleen
  - Left kidney (inferior, medial, and posterior)
  - Left colic flexure (inferior)
    - Organ of mesodermal origin

Vasculature and innervation of the spleen

	Structure	Course	Notable features
Arteries	• Splenic artery	• Celiac trunk → superior border of pancreas → hilum of spleen → branches into central and penicillar arterioles	• Vessels that arise from the splenic artery ◦ Short gastric arteries ◦ Left gastroepiploic artery • Located inside the splenorenal ligament • Supplies the pancreas while flowing superior to it (retroperitoneal course until the hilum of the spleen)
Veins	• Splenic vein	• Hilum of spleen → meets superior mesenteric vein to form the portal vein	• Veins that empty into the splenic vein ◦ Short gastric vein ◦ Left gastroepiploic vein ◦ Pancreatic veins from body and tail of pancreas ◦ Inferior mesenteric vein
Lymphatics	• Celiac nodes	• Follow course of splenic artery	• Efferent lymphatics only
Innervation	• Celiac plexus • Vagus nerve	• Follow course of splenic artery	• Sympathetic (celiac plexus) and parasympathetic (vagus nerve) innervation

❖Kidney

Function

- **Production of urine**
  - Excretion of metabolic waste and end-products of metabolism
  - Regulation of extracellular fluid volume and osmolality
  - Maintenance of acid-base balance
  - Maintenance of electrolyte concentrations
  - Regulation of blood pressure and blood volume
  - Participation in gluconeogenesis (glutamine and glutamate) and ketogenesis
- **Hormone synthesis**
  - Erythropoietin
  - Calciferol
  - Prostaglandins
  - Dopamine
  - Renin

- **paired retroperitoneal organs**
- **Located at the superior pole: adrenal gland**
- **Organ of mesodermal origin**

6.12 Differentiating a palpable spleen from the left kidney

Distinguishing feature	Spleen	Kidney
Mass is smooth and regular in shape	More likely	Polycystic kidneys are bilateral irregular masses
Mass descends in inspiration	Yes, travels superficially and diagonally	Yes, moves deeply and vertically
Ability to feel deep to the mass	Yes	No
Palpable notch on the medial surface	Yes	No
Bilateral masses palpable	No	Sometimes, e.g. polycystic kidneys
Percussion resonant over the mass	No	Sometimes
Mass extends beyond the midline	Sometimes	No (except with horseshoe kidney)

❖Large intestine

The large intestine is the terminal portion of the **gastrointestinal tract and is approx. 1.5 m long**. The large intestine is divided into the cecum and appendix, the ascending colon, transverse colon, descending colon, sigmoid colon, rectum, and anal canal.

❖ Embryology

- Midgut: from the distal duodenum through the proximal two-thirds of the transverse colon
- Hindgut (endoderm): from the distal third of the transverse colon through the anal canal above the pectinate line
- Proctodeum (ectoderm): anal canal below the pectinate line

❖Subdivisions of the large intestine

Cecum

- Intraperitoneal
- U-shaped, sac-like structure located in the right iliac fossa
- The three teniae coli converge at the base of the cecum.
- Receives chyme through the ileocecal junction

Vermiform appendix

- Intraperitoneal
- Blind tubular structure that arises from the base of the cecum
- Located in the right iliac fossa
- The position of its free end is variable.
  - The most common position is **retrocecal**
  - Other positions include paracecal , preileal , postileal , and pelvic

❖ **McBurney point represents where the base of the appendix lies in the right iliac fossa. Tenderness at this point is a sign of acute appendicitis.**

Colon

- Connects the cecum proximally and the rectum distally
- **Ascending colon**
  - Retroperitoneal
  - Ascends along the right posterolateral abdominal wall from the cecum up to the right subcostal region, where it makes a 90° turn to the left (hepatic flexure)
- **Transverse colon**
  - Intraperitoneal
  - Extends from the hepatic flexure to the splenic hilum, where it makes a 90° turn caudally (splenic flexure)
- **Descending colon**
  - Retroperitoneal
  - Descends along the left posterolateral abdominal wall from the splenic flexure to the left iliac fossa
- **Sigmoid colon**
  - Intraperitoneal
  - The S-shaped terminal portion of the descending colon located in the left iliac fossa
  - Extends up to the S3 vertebra

❖ **The intraperitoneal parts of the large intestine (i.e., the cecum, transverse colon, and sigmoid colon) are susceptible to volvulus.**

Rectum

- Partially retroperitoneal; does not have a mesentery
- Extends from the S3 vertebra to the anorectal junction
- The peritoneum on the anterior rectal wall reflects anteriorly onto the bladder in males and the uterus in females, forming a blind pouch.

- Rectovesical pouch (in males): separates the anterior wall of the rectum from the posterior wall of the bladder, the prostate, the seminal vesicles, and vas deferens
- Rectouterine pouch (in females): separates the anterior wall of the rectum from the posterior wall of the uterus and upper vagina

- **Anorectal junction**
  - Located at the pelvic diaphragm
  - Anorectal flexure
    - Puborectalis muscle forms a sling around the anorectal junction, forming a posterior curve
    - Contributes to fecal continence

Anal canal

- Extraperitoneal
- The terminal part of the gastrointestinal tract
- **Approx. 4 cm long**
- Extends from the anorectal junction at the pelvic diaphragm to the anal orifice
- **Pectinate line (dentate line)**
  - A circumferential scalloped line formed by the anal valves at the inferior end of the anal columns
  - Divides the anal canal into proximal and distal thirds
    - Internal anal sphincter
      - An involuntary smooth muscle sphincter
      - Innervated by the autonomic nervous system
    - External anal sphincter
      - Voluntary skeletal muscle sphincter
      - Innervated by the somatic nervous system (inferior rectal branch of the pudendal nerve)
    - Anal glands lie in the intersphincteric groove between the internal and external anal sphincters.

		Arteries	Veins	Lymphatics	Innervation
Midgut derivatives Cecum, appendix, ascending colon, proximal 2/3 of the transverse colon		• Branches of the superior mesenteric artery (SMA)	• Branches of the **superior mesenteric vein** → portal vein	• Superior mesenteric lymph nodes: colon to splenic flexure	• Visceral: superior mesenteric plexus
Hindgut derivatives Distal 1/3 of the transverse colon, descending colon, and sigmoid colon		• Branches of the inferior mesenteric artery (IMA)	• Left colic vein and sigmoid veins drain into the **inferior mesenteric vein** → splenic vein → portal vein	• Inferior mesenteric lymph nodes: colon from splenic flexure to upper rectum	• Visceral: inferior mesenteric plexus
Rectum and anal canal	Above pectinate line	• **Superior rectal artery**	• **Superior rectal vein** → inferior mesenteric vein → splenic vein → **portal vein**	• Internal iliac lymph nodes	
	Below pectinate line	• **Middle rectal artery** • **Inferior rectal artery**	• Middle and inferior rectal vein → internal pudendal vein → internal iliac vein → common iliac vein → **inferior vena cava**	• Superficial inguinal lymph nodes	• Somatic: inferior rectal branch of the **pudendal nerve** (S2–S4)

- Internal hemorrhoids occur above the pectinate line (superior rectal vein) and are not painful (visceral innervation). External hemorrhoids occur below the pectinate line and are painful because the pudendal nerve provides this area with somatic innervation.

- The pudendal nerve (S2–S4) innervates the external anal sphincter. Injury to this nerve (e.g., during childbirth) can cause fecal incontinence and perianal sensory loss.

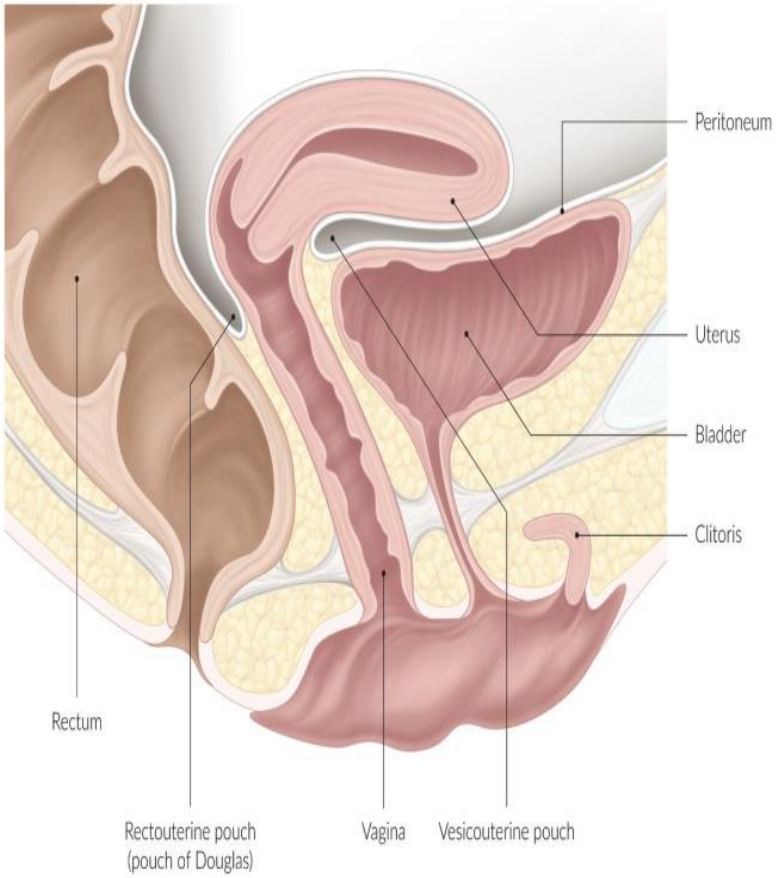
- The rectum is a site of portosystemic anastomosis. Rectal varices develop in portal hypertension due to the shunting of venous blood from the superior rectal vein (portal system) to the middle and inferior rectal veins (systemic or caval circulation).

- Watershed areas of the colon: [4]

- The splenic flexure (Griffiths point): junction between the SMA and IMA, located between the left colic artery and the marginal artery of Drummond
- Rectosigmoid junction (Sudeck point): junction between the IMA and internal iliac artery, located between the last sigmoid branch of the IMA and the superior rectal artery
- The watershed areas of the splenic flexure (Griffiths point) and rectosigmoid junction (Sudeck point) are the regions of the colon at highest risk of ischemia secondary to hypoperfusion.

❖ Rectum and anal canal :

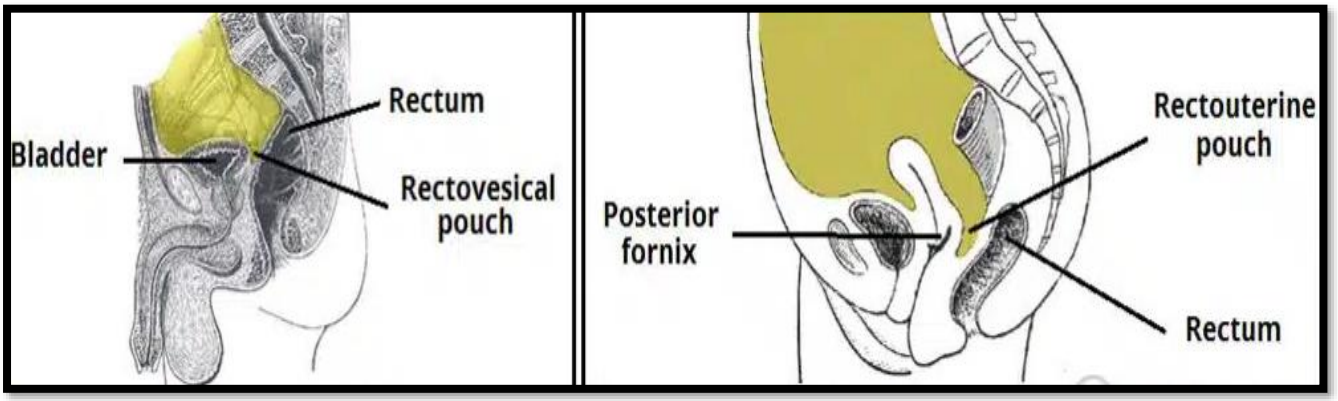
The rectum The rectum is continuous with the sigmoid colon and extends **13 to 15 cm (5 to 6 inches)** to the anus begins at the level of the S3. It is distinct from the colon, with an **absence** of taenia coli, haustra, and omental appendices



Partially retroperitoneal

In the superior third of the rectum, the anterior surface and lateral sides are covered by peritoneum. The middle third only has an anterior peritoneal covering, and the **lower 1/3 has no peritoneum associated with it**

In males, the reflection of peritoneum from the rectum to the posterior bladder wall forms the **rectovesical pouch**. **In females**, the peritoneum reflects to the posterior vagina and cervix, forming the **rectouterine pouch (pouch of Douglas)**



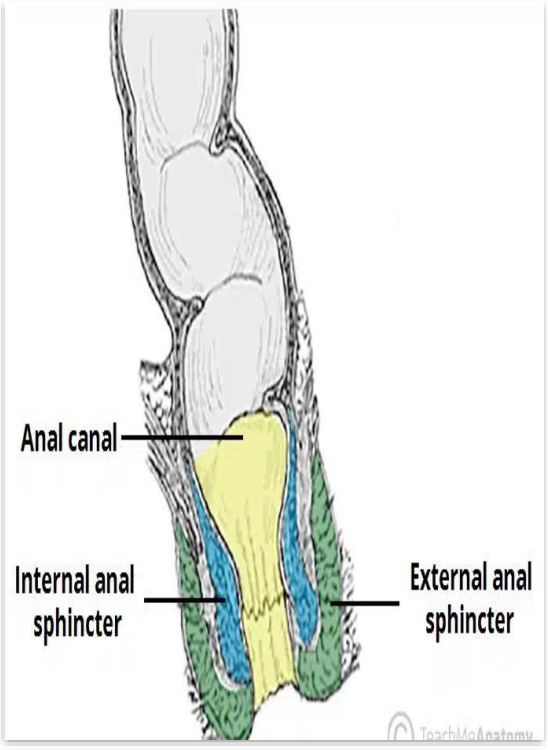
- ✓ **The anal canal** is located within the anal triangle of the perineum between the right and left ischioanal fossae. It is the final segment of the gastrointestinal tract, around 4cm in length
- ✓ The canal begins as a continuation of the rectum and passes inferoposteriorly to terminate at the anus

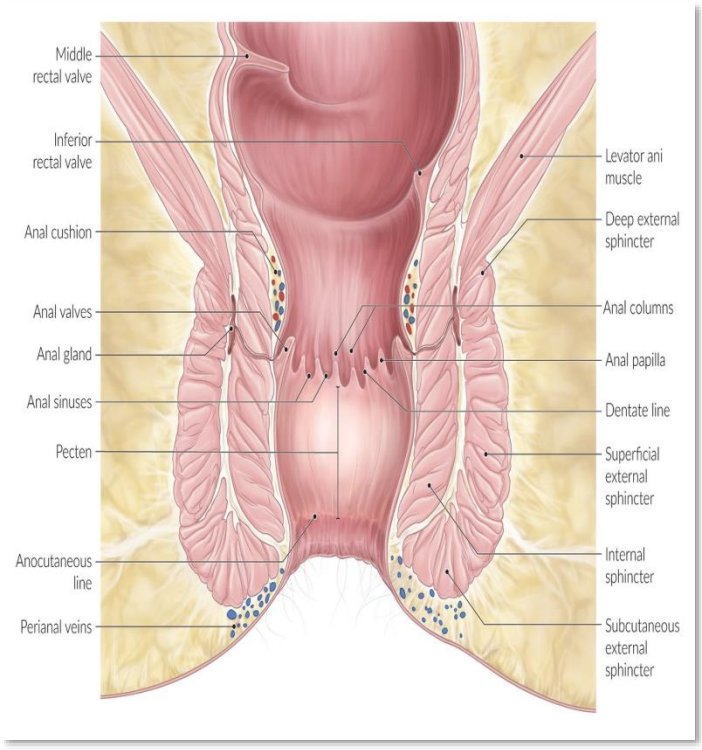
Anal Sphincters:

The anal canal is surrounded by internal and external anal sphincters, which play a crucial role in the maintenance of faecal continence:

- ✓ **Internal anal sphincter –** surrounds the upper 2/3 of the anal canal. It is formed from a thickening of the involuntary circular smooth muscle in the bowel wall.
- ✓ **External anal sphincter –** voluntary muscle that surrounds the lower 2/3 of the anal canal (and so overlaps with the internal sphincter). It blends superiorly with the puborectalis muscle of the pelvic floor.

At the junction of the rectum and the anal canal, there is a muscular ring – known as the **anorectal ring**. It is formed by the fusion of the internal anal sphincter, external anal .sphincter and puborectalis muscle, and is palpable on **digital rectal examination**

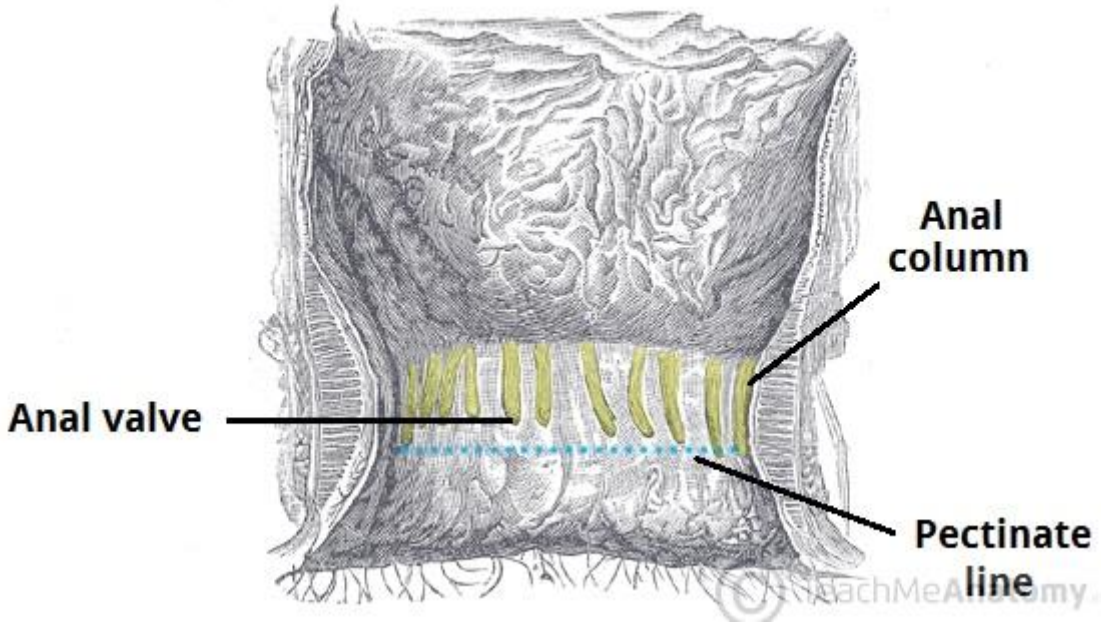




in the anal canal, the mucosa is organised into longitudinal folds, known as **anal columns.** These are joined at their inferior ends by **anal valves.** Above the anal valves are small pouches which are referred to as **anal sinuses** – these contain glands that secrete mucus

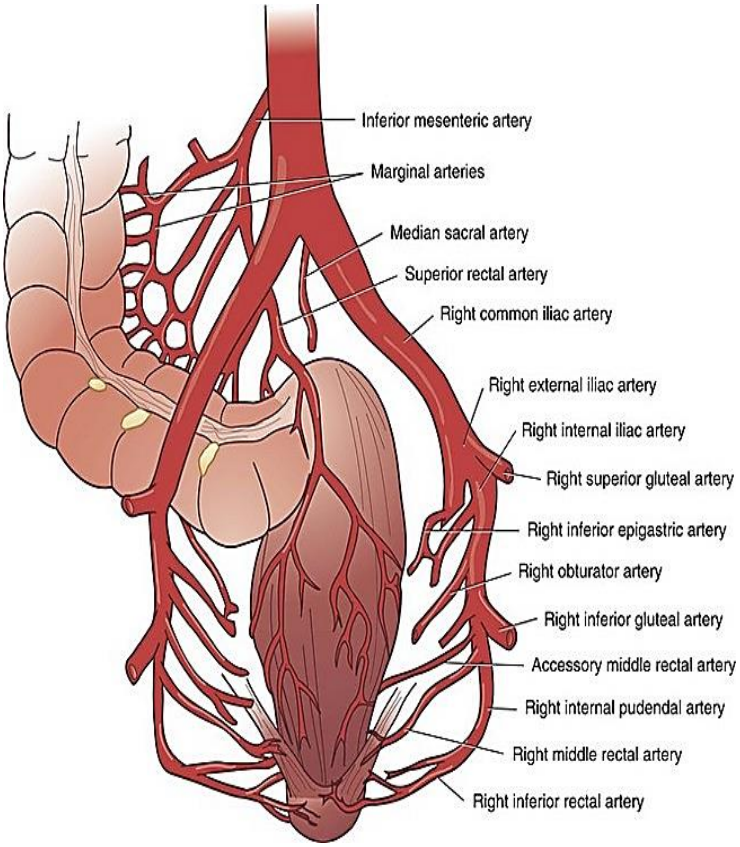
The anal valves collectively form an irregular circle – known as the **pectinate line (dentate line).** This line divides the anal canal into upper and lower parts, which differ in both structure and neurovascular supply. This is a result of their different embryological origins

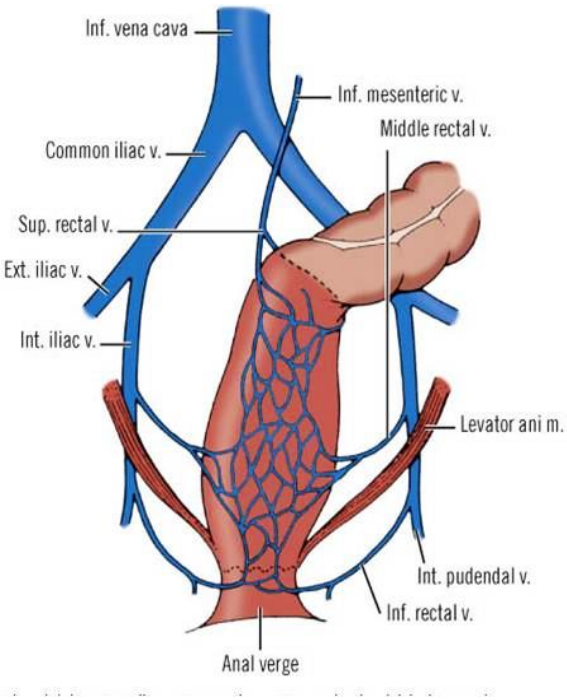
- ✓ Above the pectinate line – derived from the embryonic hindgut
- ✓ Below the pectinate line – derived from the ectoderm of the proctodeum



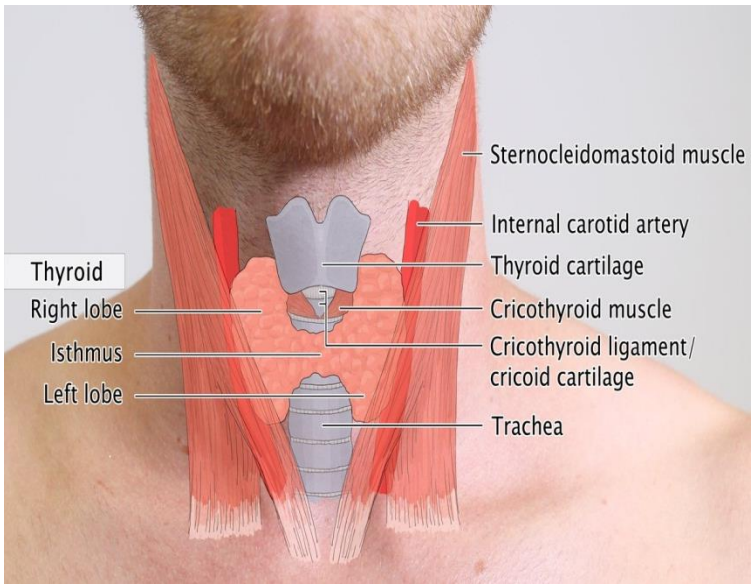
❖ Vasculature and innervation of Rectum and anal canal :

Modality	Above Pectinate line	Below Pectinate line
Arterial Supply	Superior rectal artery (branch of inferior mesenteric artery) Anastomosing branches from the middle rectal artery.	Inferior rectal artery (branch of the internal pudendal artery) Anastomosing branches from the middle rectal artery.
Venous Drainage	Superior rectal vein, which empties into the inferior mesenteric vein (portal venous system).	Inferior rectal vein, which empties into the internal pudendal vein (systemic venous system).
Nerve Supply	Visceral innervation via the inferior hypogastric plexus. Sensitive to stretch.	Somatic innervation via the inferior rectal nerves (branches of the pudendal nerve) Sensitive to pain, temperature, touch and pressure.
Lymphatics	Internal iliac lymph nodes	Superficial inguinal lymph nodes





❖Thyroid gland



butterfly-shaped, unpaired endocrine gland composed of left lobe and right lobe connected by an isthmus.

Extends from C5–T1

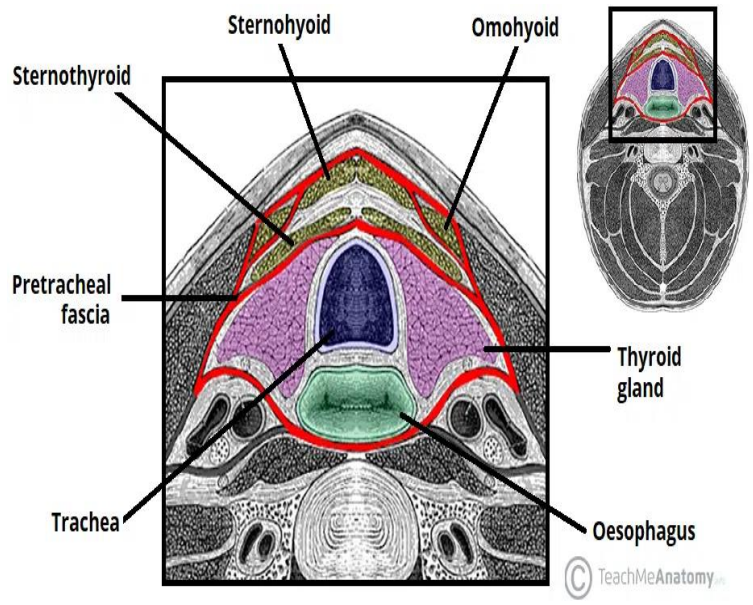
Surrounded by pretracheal fascia (along with pharynx, trachea, esophagus

Relations of the thyroid gland :

Anteriorly: strap muscles(sternohyoid, sternothyroid, thyrohyoid , omohyoid)

Medially: the trachea, esophagus, recurrent laryngeal nerve ,the external branch of the superior laryngeal nerve

Posteriorly: the parathyroid glands cricoid cartilage, lower thyroid cartilage, and the carotid sheath with its contents (internal jugular vein, vagus nerve, and common carotid artery)



Embryology of thyroid gland

The thyroid gland develops in the first trimester of pregnancy from the fusion of the **median thyroid anlage** with the **two lateral thyroid anlages** derived from **the pharyngeal pouches**. Both follicular cells and C cells arise from pharyngeal endoderm

A thyroid gland precursor that originates from the floor of the primordial pharynx

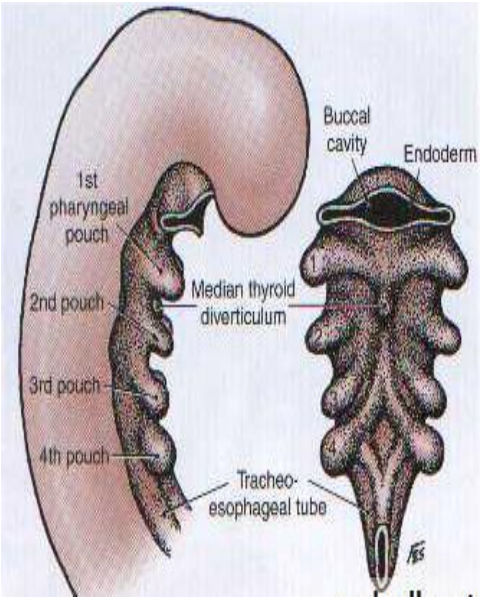
It is located initially at the middle of the floor of the pharynx, near the base of the tongue i.e foramen cecum

Median thyroid anlage

An endodermal thickening in the floor of the primordial pharynx between the **1st and 2nd pharyngeal pouches**

This thickening becomes the thyroid diverticulum

Differentiates into the **follicular cells** of the thyroid gland

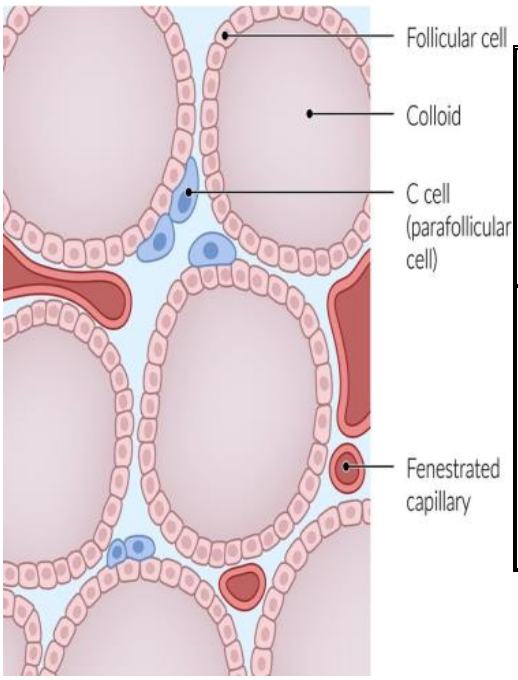


Lateral thyroid anlagen

Paired endodermal cell thickenings derived from the **4th branchial pouch**

Fuse with the median thyroid anlage

Differentiate into the **parafollicular C cells** of the thyroid gland



Thyroid epithelial cell (follicular cell)	**arranged in spherical follicles surrounding colloid** **Synthesize, secrete, and store thyroglobulin and thyroid peroxidase**
C cells (parafollicular cell)	**found along the basement membrane of the thyroid epithelium** **Hormone production and storage in granules as calcitonin**

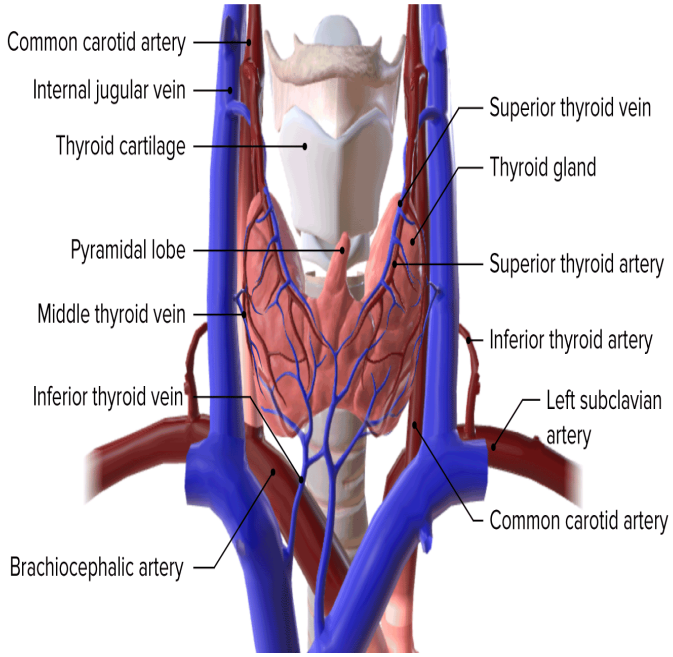
arterial supply and venous drainage

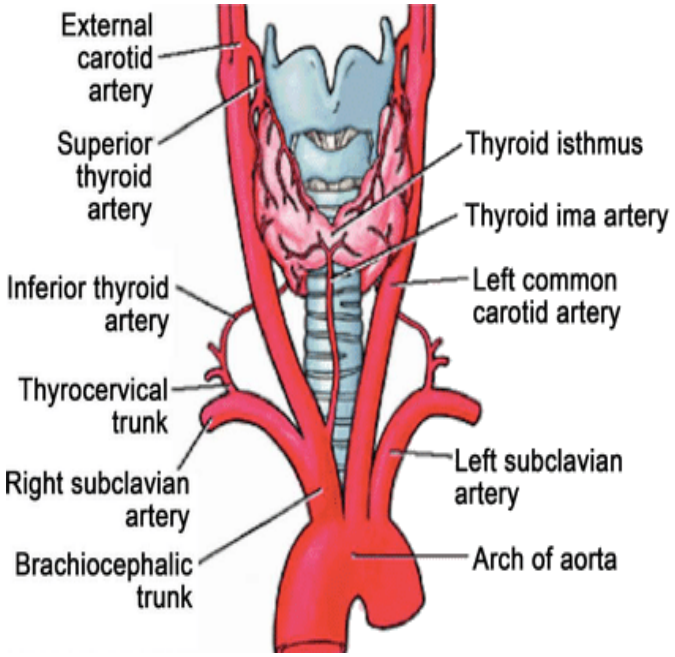
Superior thyroid artery of external carotid artery → **Supplie** → superior and anterior portions of the gland; Superior parathyroid glands

Inferior thyroid artery from the thyrocervical trunk (branch of (subclavian artery → **Supplie** → Posterior and inferior portions of the gland; Inferior parathyroid glands

Thyroid ima artery from the brachiocephalic trunk of the arch of aorta → **Supplies** → Anterior surface and isthmus

Superior thyroid veins; Middle thyroid veins; Inferior thyroid veins → **Drain into** → internal jugular vein; right and left brachiocephalic veins



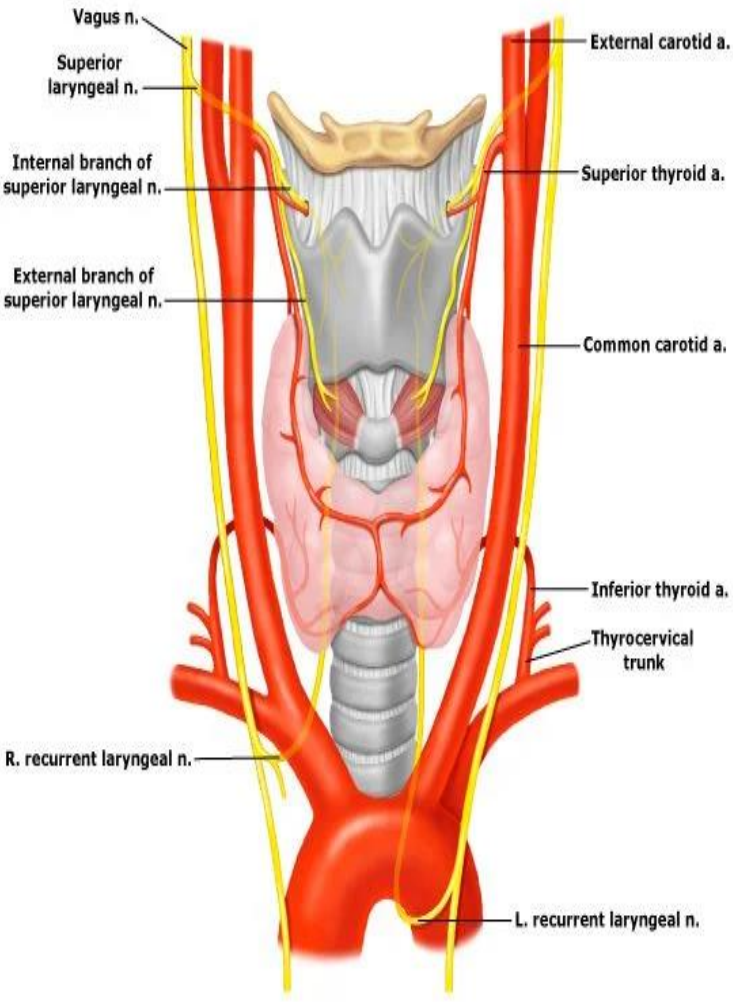


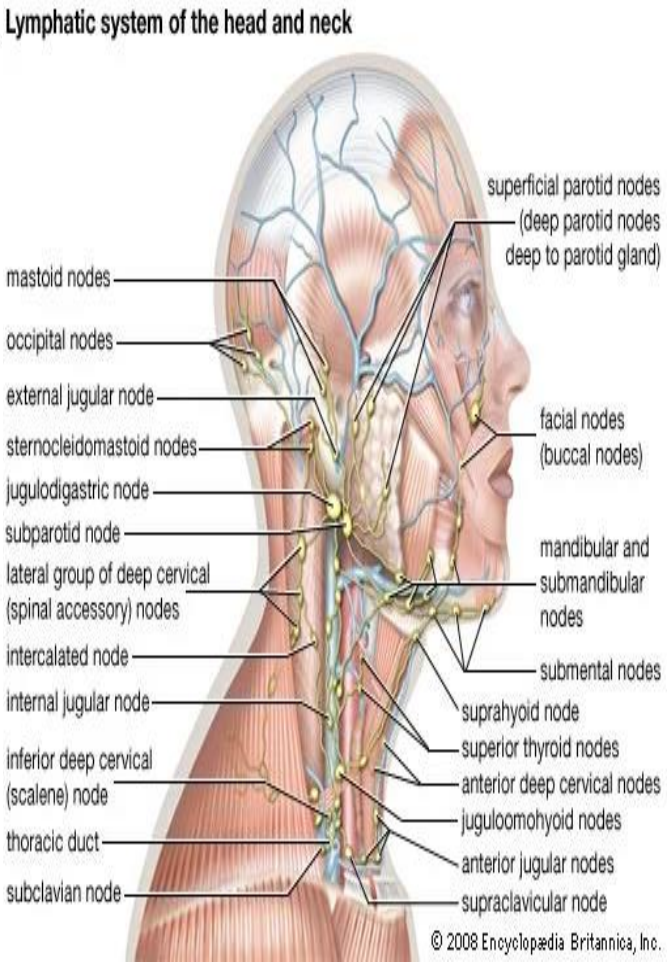
Lymphatics

- Paratracheal nodes
- Deep cervical nodes

Innervation

- Vagus nerve (parasympathetic)
- Superior, middle, and inferior cervical ganglia of the sympathetic trunk





❖parathyroid glands

There are four, oval-shaped endocrine glands embedded in the **posterior surface** of the thyroid gland

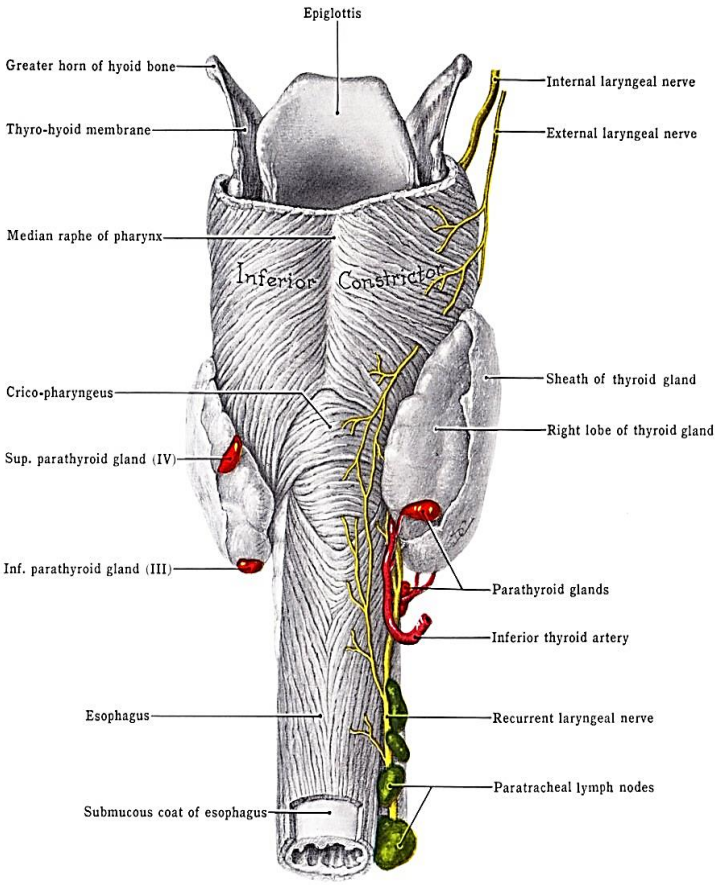
❖ **Two superior parathyroid glands**

derived from the **fourth pharyngeal pouch**

❖ **Two inferior parathyroid glands**

derived from the **third pharyngeal pouch**

Function: secretion of parathyroid hormone (PTH) in response to low calcium serum levels

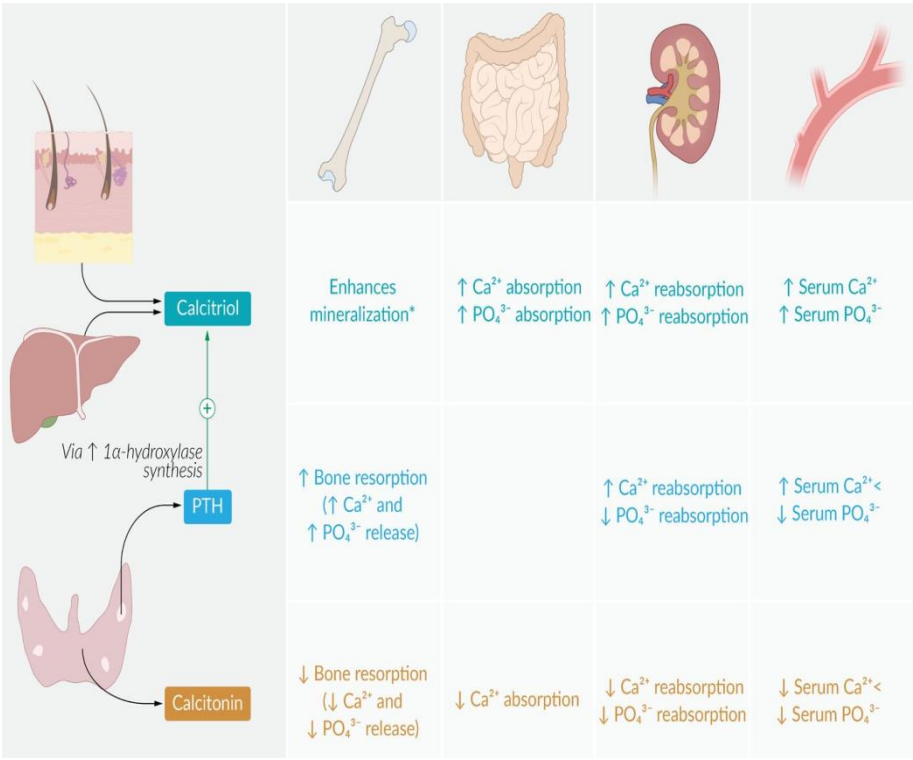


Cell types:

Adipocytes ~ 50%

Parathyroid cells(parathyroid chief cells)

Oxyphil cells



Vasculature

Arterial supply: inferior thyroid arteries

Venous drainage: thyroid plexus of veins

Lymphatic drainage: deep cervical nodes, paratracheal nodes

Innervation: thyroid branches of the cervical ganglia

❖ Adrenal gland

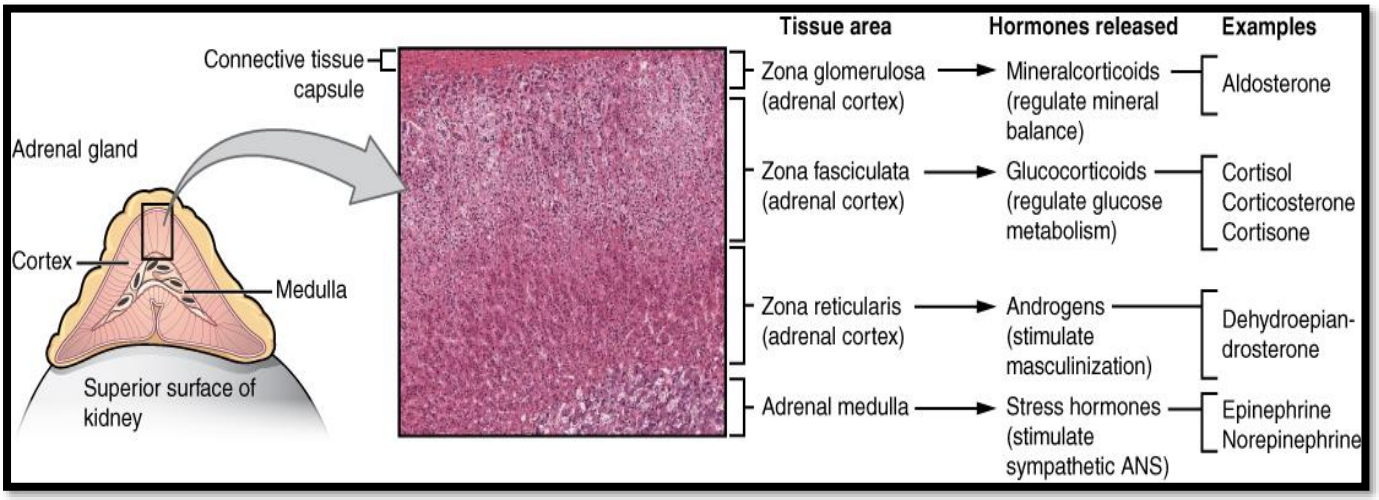
- ✓ The adrenal glands are located in the posterior abdomen, between the superomedial kidney and the diaphragm. They are retroperitoneal, with parietal peritoneum covering their anterior surface only
- ✓ The right gland is **pyramidal** in shape, contrasting with the **semi-lunar** shape of the left gland.

The adrenal glands consist of an outer connective tissue **capsule**, a **cortex** and a **medulla**. Veins and lymphatics leave each gland via the **hilum**, but arteries and nerves enter the glands at numerous sites

The outer cortex and inner medulla are the functional portions of the gland.

They are two separate endocrine glands, with different embryological origins

- ✓ **Cortex** – derived from the embryonic mesoderm
- ✓ **Medulla** – derived from the ectodermal neural crest cell



❖ Blood supply and lymphatics

Lymphatic drainage:

- ✓ Left aortic lymph nodes
- ✓ Right caval lymph nodes

Innervation:

- ✓ Sympathetic: preganglionic sympathetic fibers from the major and minor splanchnic nerves
- ✓ Parasympathetic: fibers from phrenic and vagal nerve

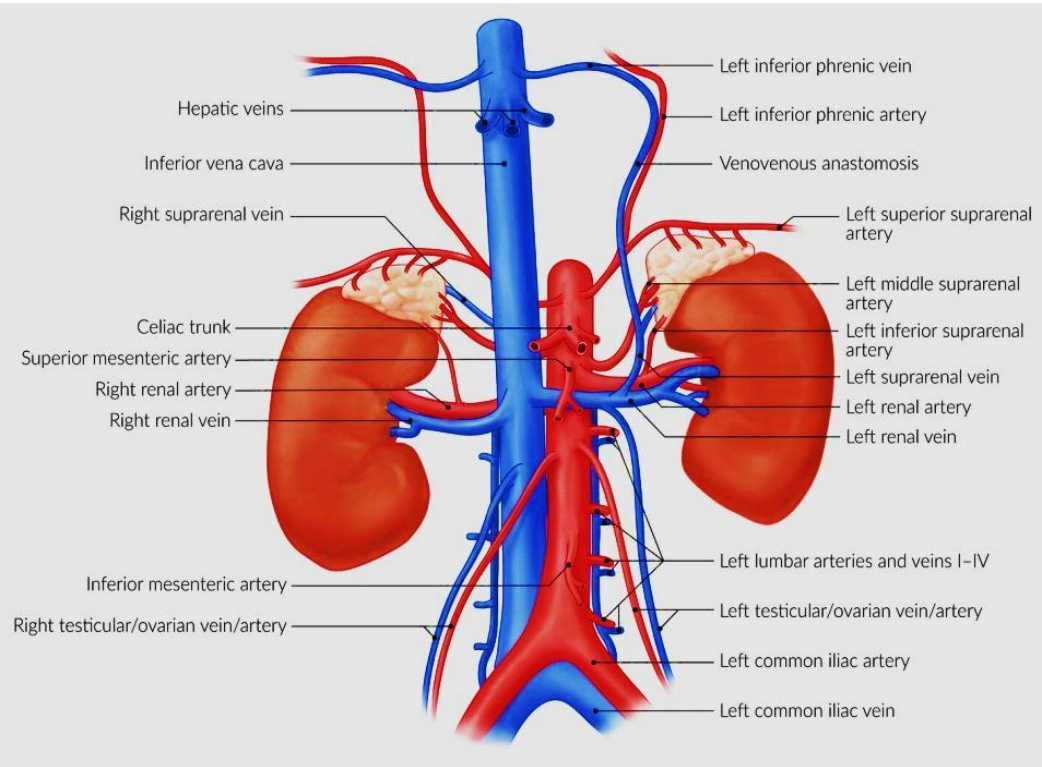
Superior adrenal artery – arises from the inferior phrenic artery

Middle adrenal artery – arises from the abdominal aorta

Inferior adrenal artery – arises from the renal arteries

The right suprarenal vein drains into the inferior vena cava

The left suprarenal vein drains into the left renal vein and then into the inferior vena cava

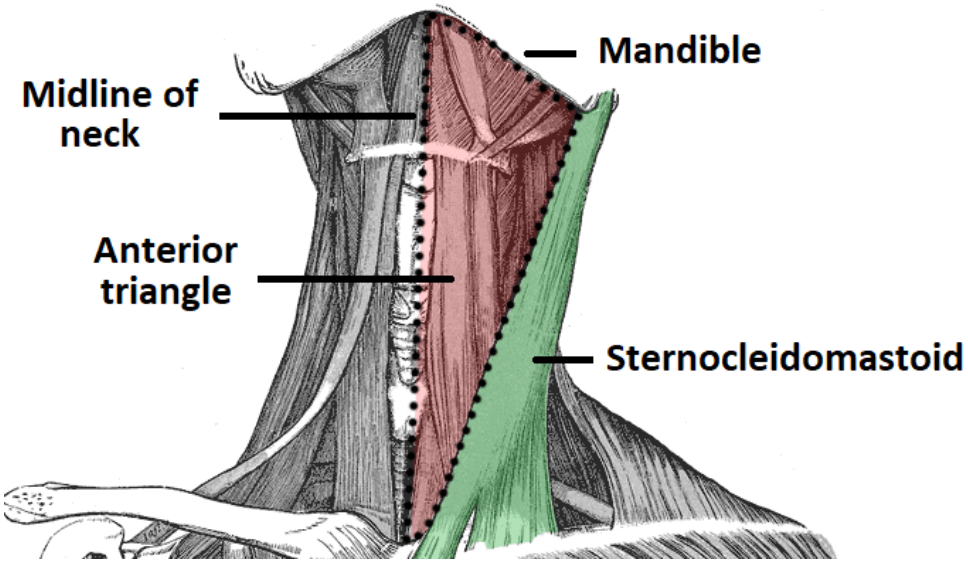


❖ The Anterior Triangle of the Neck

Borders

The anterior triangle is situated at the front of the neck. It is bounded:

- ✓ **Superiorly** – inferior border of the mandible (jawbone)
- ✓ **Laterally** – anterior border of the sternocleidomastoid
- ✓ **Medially** – sagittal line down the midline of the neck



Contents

The muscles in this part of the neck are divided as to where they lie in relation to the hyoid bone. The **suprahyoid muscles** (Stylohyoid , Digastric , Mylohyoid Geniohyoidare) located superiorly to the hyoid bone, and **infrahyoid smuscles** (Omohyoid, Sternohyoid ,Thyrohyoid, Sternothyroid) inferiorly.

The **common carotid artery** bifurcates within the triangle into the external and internal carotid branches. The **internal jugular vein** can also be found within this area.

The cranial nerves in the anterior triangle are the **facial [VII], glossopharyngeal [IX], vagus [X], accessory [XI], and hypoglossal [XII] nerves**

❖ **The anterior triangle is subdivided by the hyoid bone, suprahyoid and infrahyoid muscles into four triangles :**

Carotid Triangle:

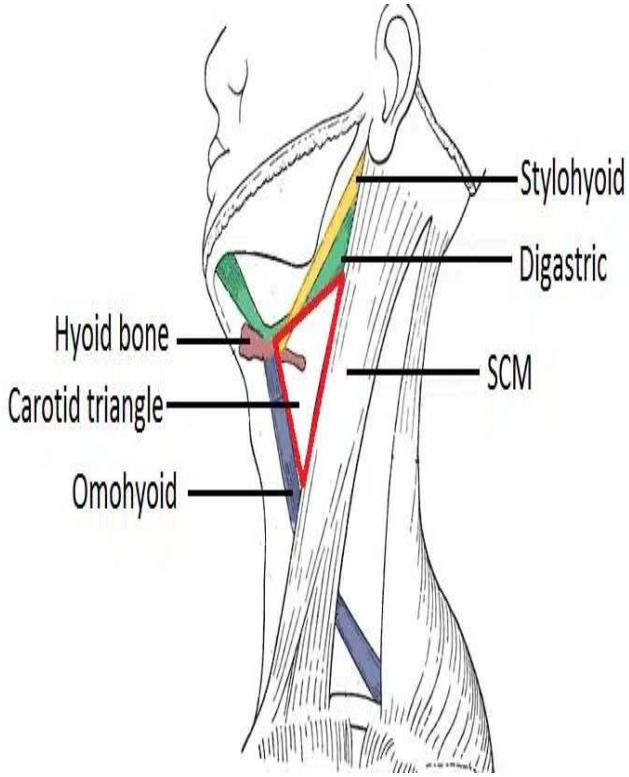
The carotid triangle of the neck has the following boundaries:

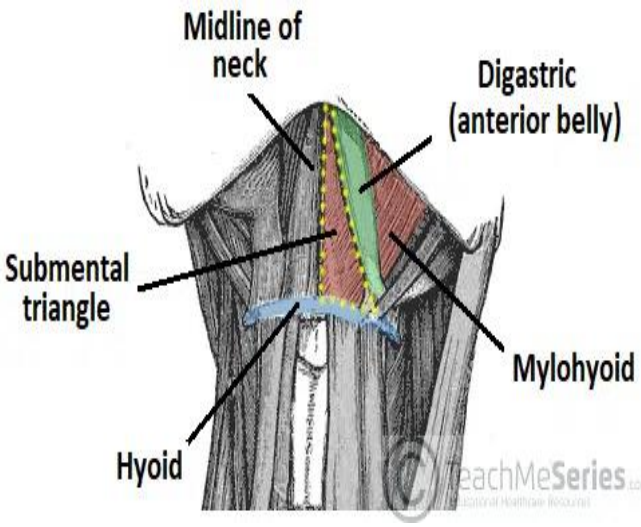
Superior – posterior belly of the digastric muscle

Lateral – medial border of the sternocleidomastoid muscle

Inferior – superior belly of the omohyoid muscle

- ✓ The main **contents** of the carotid triangle are the common carotid artery, the internal jugular vein, and the hypoglossal and vagus nerves





Submental Triangle:

The submental triangle in the neck is situated underneath the chin. It **contains** the submental lymph nodes, which filter lymph draining from the floor of the mouth and parts of the tongue

It is bounded:

Inferiorly – hyoid bone

Medially – midline of the neck

Laterally – anterior belly of the digastric

Submandibular Triangle

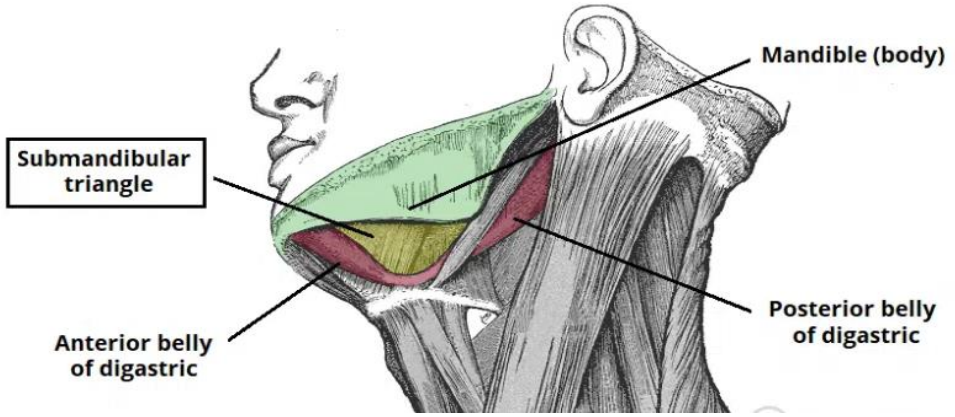
The submandibular triangle **contains** the submandibular gland (salivary), and lymph nodes. The facial artery and vein also pass through it.

The boundaries of the submandibular triangle:

Superiorly – body of the mandible

Anteriorly – anterior belly of the digastric muscle

Posteriorly – posterior belly of the digastric muscle



Muscular Triangle

The muscular **contains** the infrahyoid muscles, the pharynx, and the thyroid, parathyroid glands

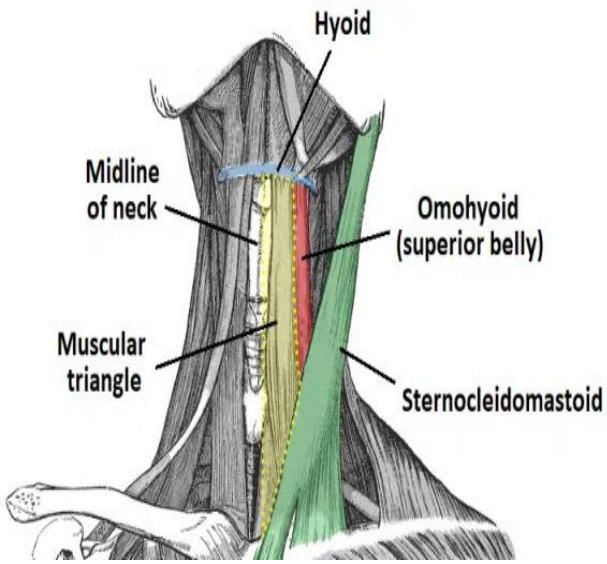
The boundaries of the muscular triangle are:

Superiorly – hyoid bone

Medially – imaginary midline of the neck

Supero-laterally – superior belly of the omohyoid muscle

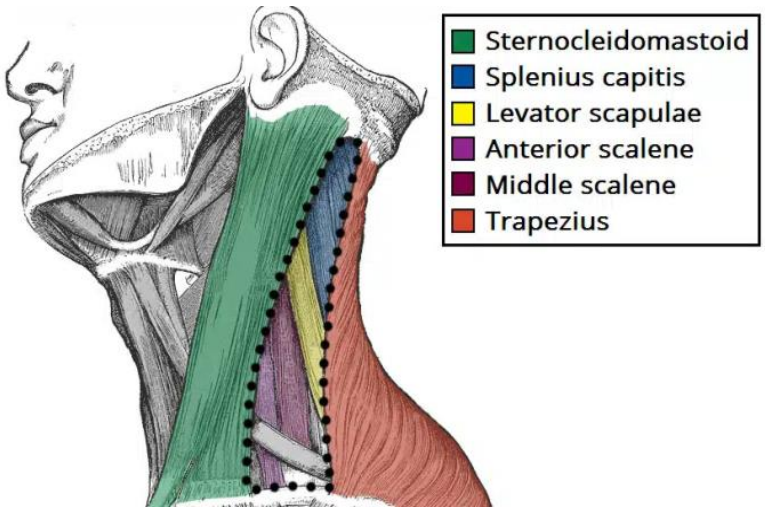
Infero-laterally – inferior portion of the sternocleidomastoid muscle



❖ The Posterior Triangle of the Neck

Borders

- ✓ **Anterior** – posterior border of the sternocleidomastoid
- ✓ **Posterior** – anterior border of the trapezius muscle
- ✓ **Inferior** – middle 1/3 of the clavicle



Contents:

A significant muscle in the posterior triangle region is the **omohyoid muscle**

A number of **vertebral muscles** (covered by prevertebral fascia) form the floor of the posterior triangle:

- ✓ Splenius capitis
- ✓ Levator scapulae
- ✓ Anterior, middle and posterior scalenes

Vasculature:

- ✓ The external jugular vein .
- ✓ The subclavian vein is often used as a point of access to the venous system, via a central catheter.
- ✓ The transverse cervical and suprascapular veins also lie in the posterior triangle.
- ✓ The subclavian, transverse cervical and suprascapular veins are accompanied by their respective arteries in the posterior triangle.

Nerves

The accessory nerve (CN XI) exits the cranial cavity, descends down the neck, innervates sternocleidomastoid and enters the posterior triangle.

The cervical plexus forms within the muscles of the floor of the posterior triangle.

The trunks of the brachial plexus also cross the floor of the posterior triangle.

Subdivisions

The omohyoid muscle divides the posterior triangle of the neck into two areas

- ✓ Occipital triangle – located superior to the omohyoid
- ✓ Subclavian triangle – located inferior to the omohyoid. It contains the distal portion of the subclavian artery

❖ Calot's Triangle

Borders

Calot's triangle is orientated so that its apex is directed at the liver. The borders

- ✓ **Medial** – common hepatic duct
- ✓ **Inferior** – cystic duct
- ✓ **Superior** – inferior surface of the liver

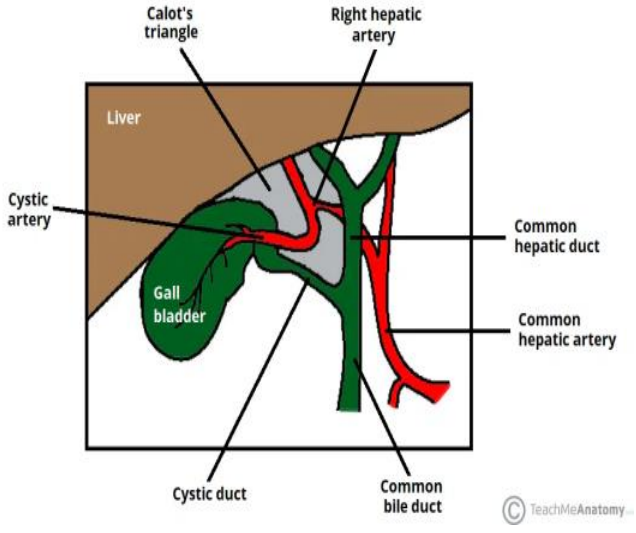
Contents

Right hepatic artery – formed by the bifurcation of the proper hepatic artery into right and left branches

Cystic artery – typically arises from the right hepatic artery and traverses the triangle to supply the gall bladder

Lymph node of Lund – the first lymph node of the gallbladder

Lymphatics



❖ The Femoral Triangle

The femoral triangle consists of three borders, a floor and a roof:

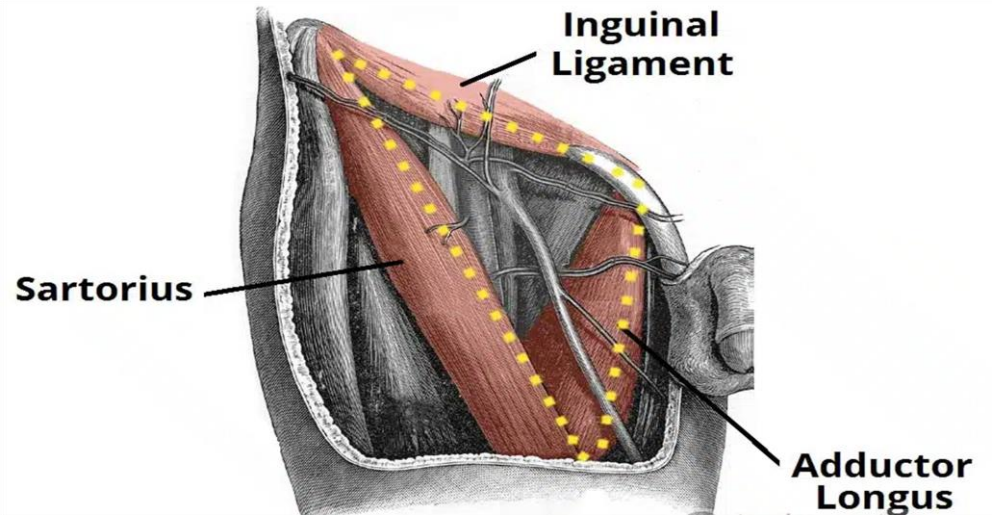
Roof – fascia lata

Floor – pectineus, iliopsoas, and adductor longus muscles

Superior border – inguinal ligament (a ligament that runs from the anterior superior iliac spine to the pubic tubercle)

Lateral border – medial border of the sartorius muscle

Medial border – medial border of the adductor longus muscle. The rest of this muscle forms part of the floor of the triangle



Contents

The femoral triangle contains some of the major neurovascular structures of the lower :limb. Its contents (lateral to medial) are:

Femoral nerve – innervates the anterior compartment of the thigh, and provides sensory .branches for the leg and foot

Femoral artery – responsible for the majority of the arterial supply to the lower limb

Femoral vein – the great saphenous vein drains into the femoral vein within the triangle

Femoral canal – contains deep lymph nodes and vessels

The femoral artery, vein and canal are contained within a fascial compartment – known as **the femoral sheath**

❖ The Inguinal (Hesselbach's) Triangle

Borders

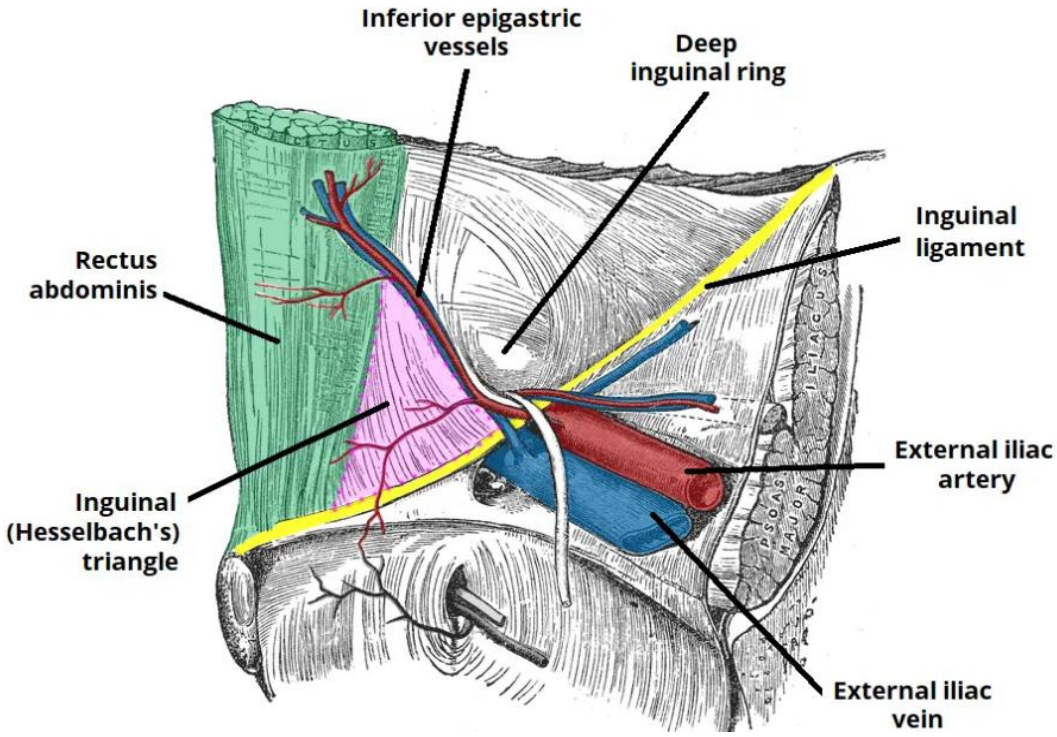
The inguinal triangle is located within the inferomedial aspect of the abdominal wall. It has the following boundaries:

- ✓ **Medial** – lateral border of the rectus abdominis muscle
- ✓ **Lateral** – inferior epigastric vessels
- ✓ **Inferior** – inguinal ligament

Contents

Other than the layers of the abdominal wall, the inguinal triangle does not contain any structures of clinical importance

However, the triangle does demarcate an area of potential weakness in the abdominal wall – through which herniation of the abdominal contents can occur.



❖ The Salivary Glands

The sublingual glands are the **smallest** of the three paired salivary glands and the most **deeply** situated

Both glands contribute to only 3-5% of overall salivary volume, producing mixed secretions which are predominately **mucous** in nature. These secretions are important in lubricating food, keeping the oral mucosa moist and initial digestion

The sublingual glands are **almond-shaped** and lie on the floor of the oral cavity. They are situated underneath the tongue, bordered laterally by the mandible and medially by genioglossus muscle of the tongue.

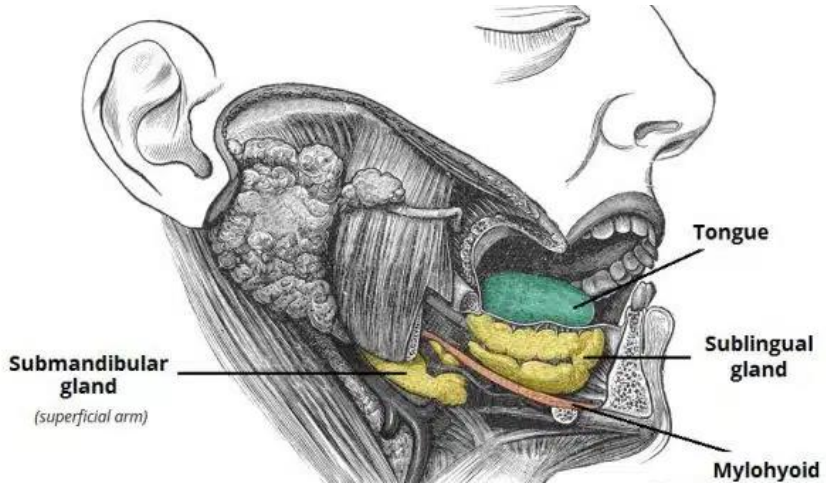
The **submandibular duct** and **lingual nerve** pass alongside the medial aspect of the sublingual gland

Secretions drain into the oral cavity by **minor sublingual ducts (of Rivinus)**, of which there are 8-20 excretory ducts per gland, each opening out onto the sublingual folds. Through anatomical variance, **a major sublingual duct (of Bartholin)** can be present in some people.

Vasculature

Blood supply is via the sublingual and submental arteries which arise from the lingual and facial arteries respectively; both of the external carotid artery

Venous drainage is through the sublingual and submental veins which drain into the lingual and facial veins respectively; both then draining into the internal jugular vein



The submandibular glands are bilateral salivary glands within the anterior part of the submandibular triangle

Their mixed serous and mucous salivary secretions are important for the lubrication of food during mastication to enable effective swallowing and aid digestion

Secretions from the submandibular glands travel into the oral cavity via the **submandibular duct (Wharton's duct)**. This is approximately **5cm** in length. The duct ascends on its course to open as 1-3 orifices on a small sublingual papilla (caruncle) at the base of the lingual frenulum bilaterally.

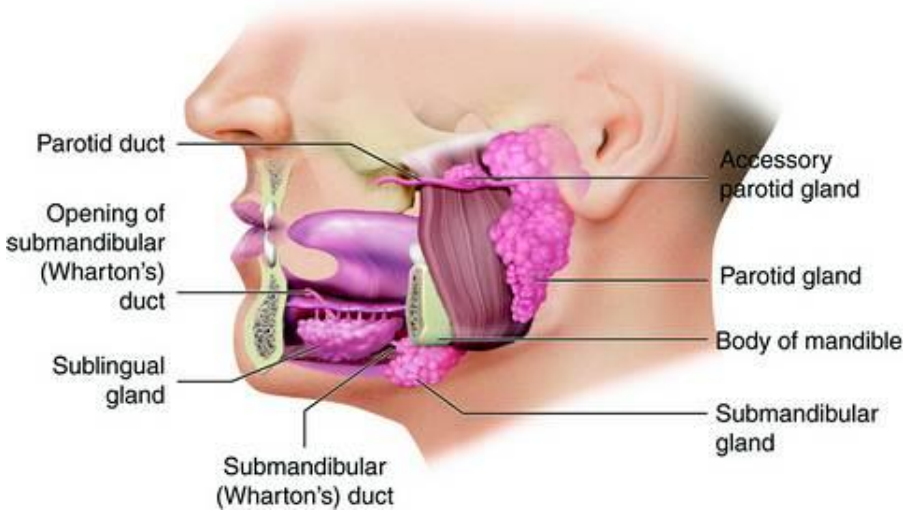
Both the submandibular gland and duct share an intimate anatomical relationship with three principal nerves; the **lingual nerve, hypoglossal nerve and facial nerve (marginal mandibular branch)**

Vasculature

The submandibular gland is **supplied by** the submental artery (branch of facial artery) and sublingual artery (branch of lingual artery)

Its **venous drainage** is by two vessels :

✓ Facial vein – empties directly into the internal jugular vein
✓ Sublingual vein – drains into the lingual vein and then internal jugular vein

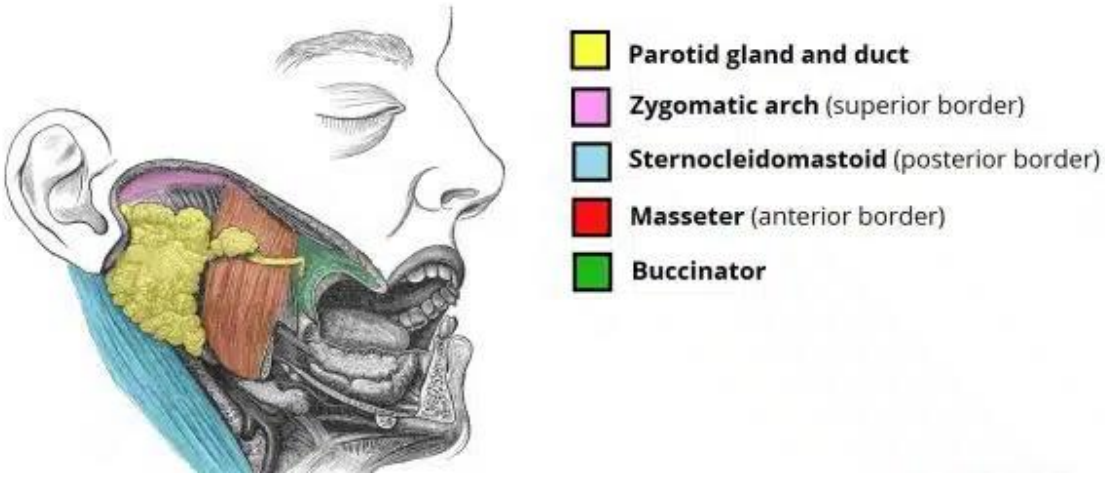


The parotid gland is a bilateral structure, which displays a lobular and irregular morphology. Anatomically, it can be divided into **deep and superficial lobes, which are separated by the facial nerve.**

It lies within a deep hollow, known as the **parotid region**. The parotid region is bounded as follows:

- ✓ Superiorly – Zygomatic arch.
- ✓ Inferiorly – Inferior border of the mandible.
- ✓ Anteriorly – Masseter muscle.
- ✓ Posteriorly – External ear and sternocleidomastoid.

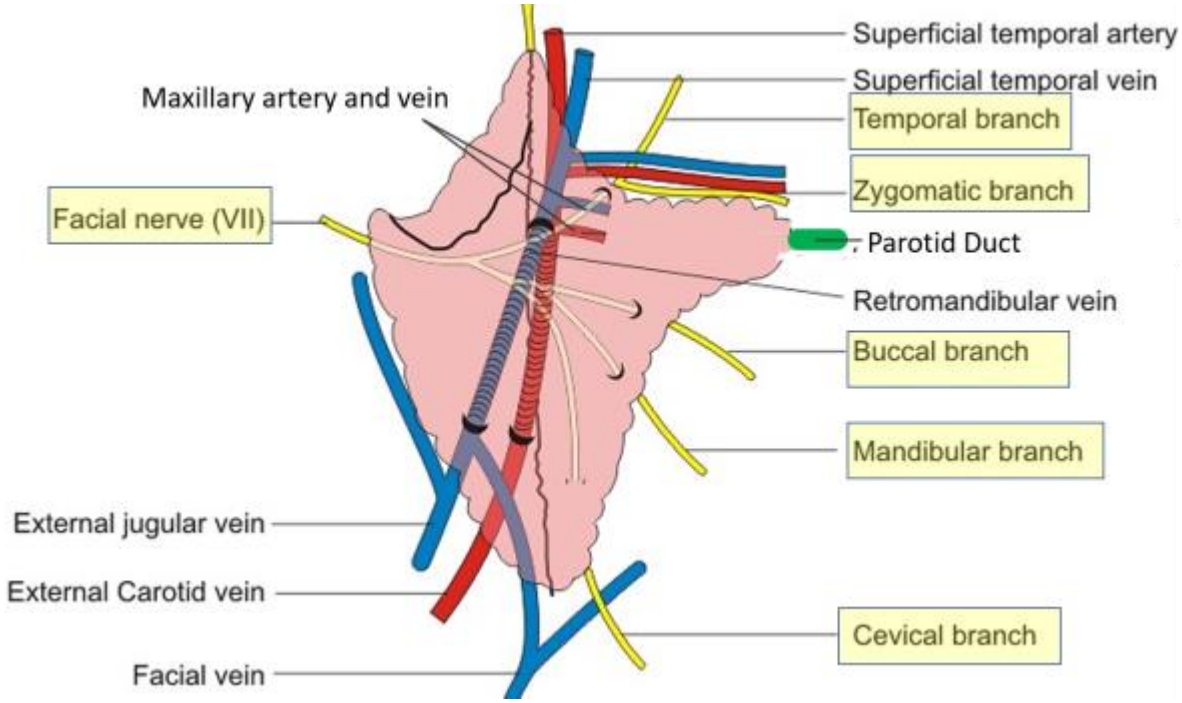
The secretions of the parotid gland are transported to the oral cavity by the **Stensen duct.** It arises from the anterior surface of the gland, traversing the masseter muscle. The duct then pierces the buccinator, moving medially. It opens out into the oral cavity near the **second upper molar**.



The anatomical relationships of the parotid gland are of great clinical importance particularly during parotid gland surgery.

Several important neurovascular structures pass through the gland:

- ✓ **Facial nerve (CN VII)** – gives rise to **five** terminal branches within the parotid gland. These branches innervate the muscles of facial expression.
- ✓ **External carotid artery** – gives rise to the posterior auricular artery within the parotid gland. It then divides into its two terminal branches – the maxillary artery and superficial temporal artery.
- ✓ **Retromandibular vein** – formed within the parotid gland by the convergence of the superficial temporal and maxillary veins. It is one of the major structures responsible for venous drainage of the face.

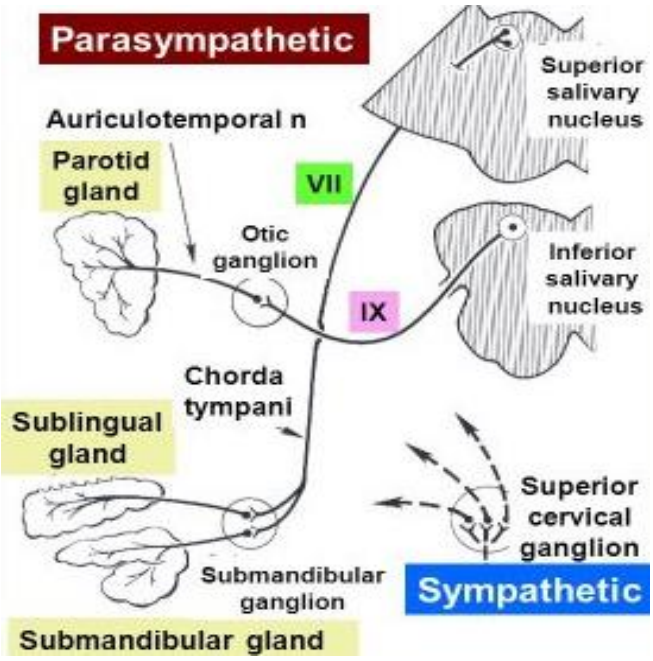


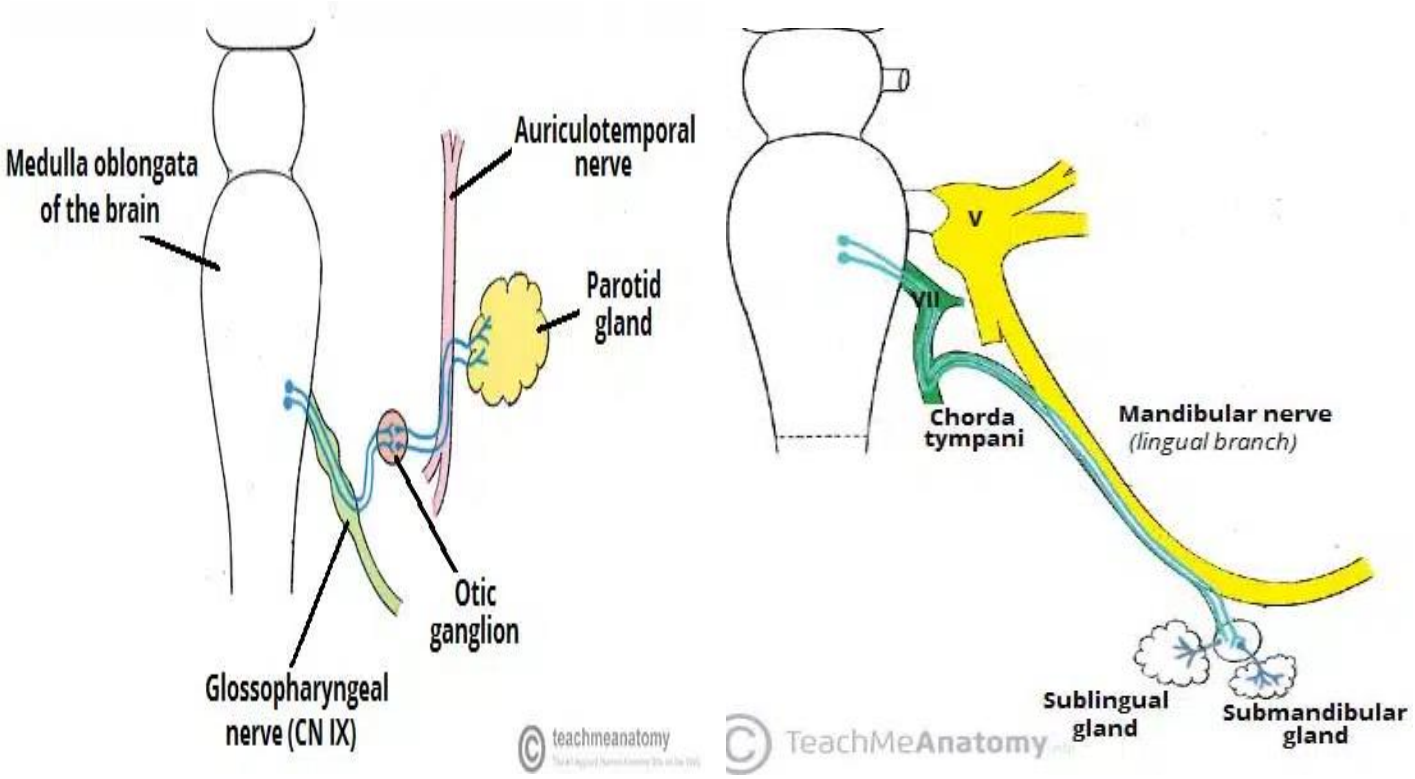
Vasculature

Blood is supplied by the posterior auricular and superficial temporal arteries. They are both branches of the external carotid artery, which arise within the parotid gland itself.

Venous drainage is achieved via the retromandibular vein. It is formed by unification of the superficial temporal and maxillary veins.

The salivary glands receive parasympathetic and sympathetic innervation.
The **parasympathetic** innervation leads to Increased saliva secretion and Increased **sympathetic** drive reduces glandular blood flow through vasoconstriction and decreases the volume of salivary secretions, resulting in a more mucus saliva.






تمّ بحمدِ الله