

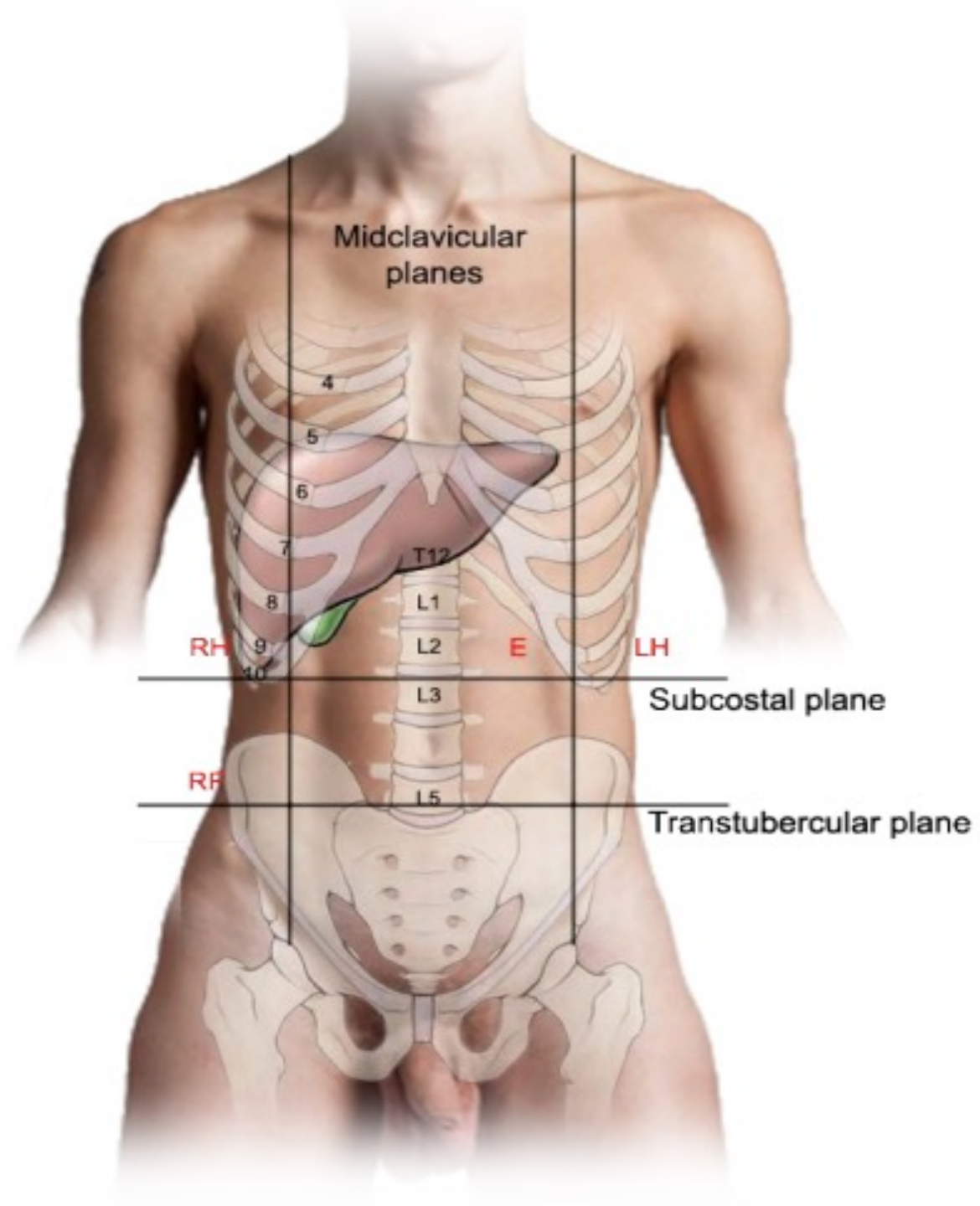
# Anatomy of the Liver, Biliary Tract, and Portal Venous System

Dr. Gary Mumaugh



# Liver

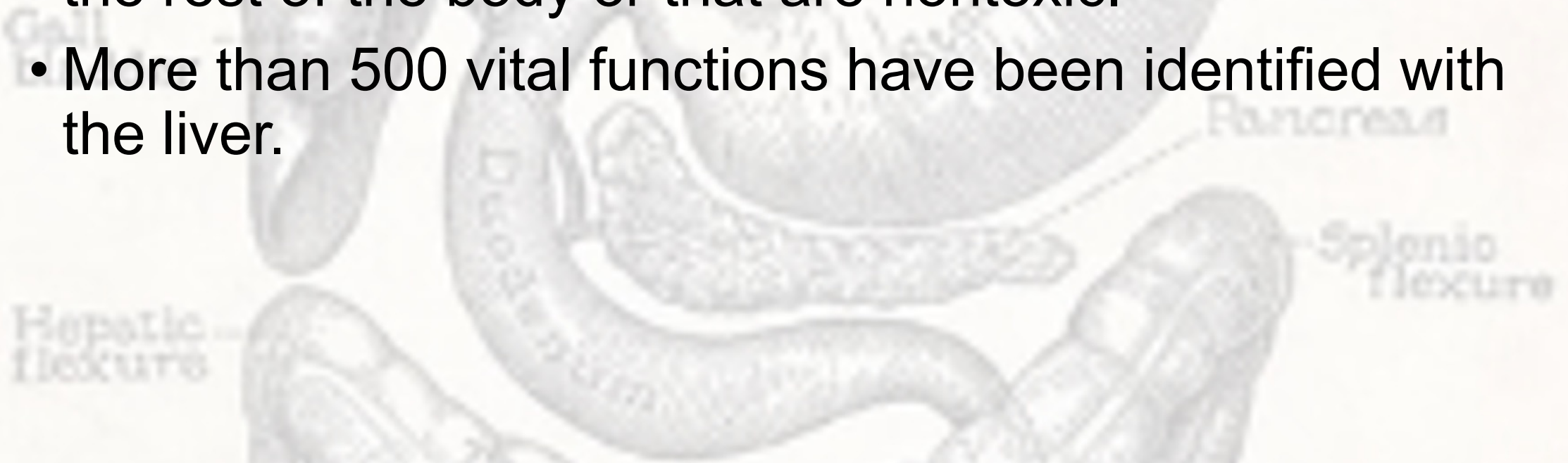
- Intraperitoneal organ
- The largest gland in the body
  - Weight 1500 gm – 3 1/2#
  - About 2.5% of body weight in adult
- Lies mainly in right upper quadrant
- Occupies most of the right hypochondrium and upper epigastrium and extends into the left hypochondrium.



- The liver lies mainly in the right upper quadrant of the abdomen, where it is protected by the thoracic (rib) cage and the diaphragm.
- The normal liver lies deep to ribs 7–11 on the right side and crosses the midline toward the left nipple.
- The liver occupies most of the right hypochondrium and upper epigastrium and extends into the left hypochondrium.
- The liver moves with the excursions of the diaphragm and is located more inferiorly when one is erect because of gravity.
- This mobility facilitates palpation.

# Liver Functions

- All the blood leaving the stomach and intestines passes through the liver.
- The liver processes this blood and breaks down, balances, and creates the nutrients and also metabolizes drugs into forms that are easier to use for the rest of the body or that are nontoxic.
- More than 500 vital functions have been identified with the liver.

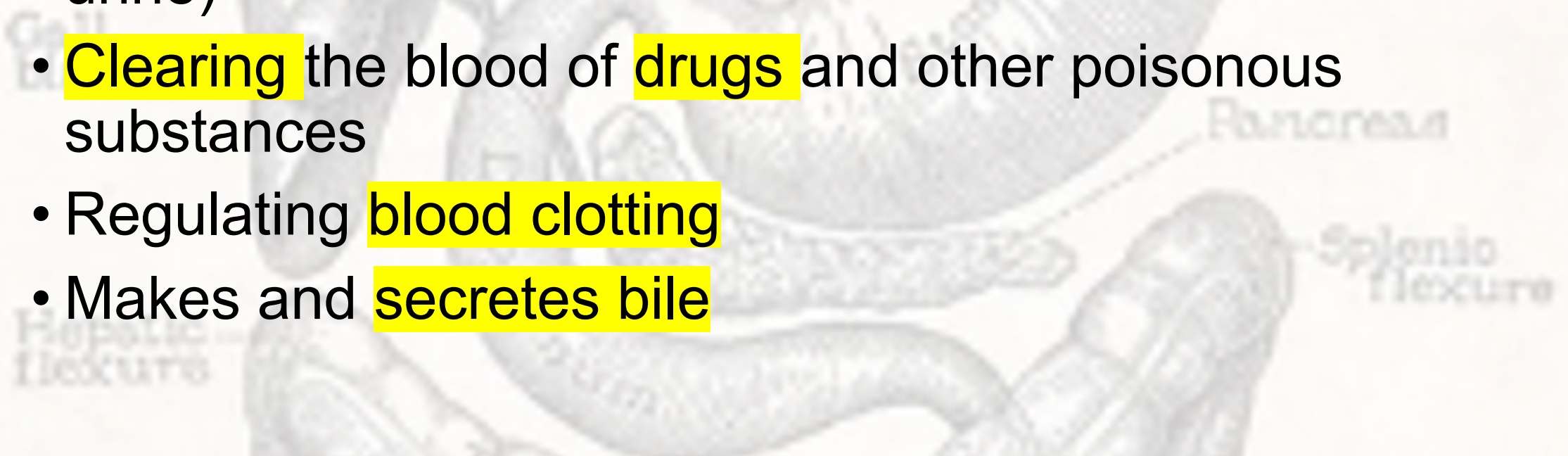


# Liver Functions

- **Production of bile**, which helps carry away waste and break down fats in the small intestine during digestion
- **Production of certain proteins** for blood **plasma**
- **Production of cholesterol** and special proteins to help carry fats through the body
- **Conversion of excess glucose** into glycogen for storage (glycogen can later be converted back to glucose for energy) and to balance and make glucose as needed
- **Regulation of** blood levels of **amino acids**, which form the building blocks of proteins

# Liver Functions

- Processing of hemoglobin for use of its iron content (the liver stores iron)
- Conversion of poisonous ammonia to urea (urea is an end product of protein metabolism and is excreted in the urine)
- Clearing the blood of drugs and other poisonous substances
- Regulating blood clotting
- Makes and secretes bile



# Liver Functions

- Resisting infections by making **immune factors** and removing bacteria from the bloodstream
- **Clearance of bilirubin**, also from red blood cells. If there is an accumulation of bilirubin, the skin and eyes turn yellow.
- In a mature fetus—when it serves as a **hematopoietic organ**—it is proportionately twice as large (5% of body weight).
- **Stores glycogen**

Hepatic flexure

Splenic flexure

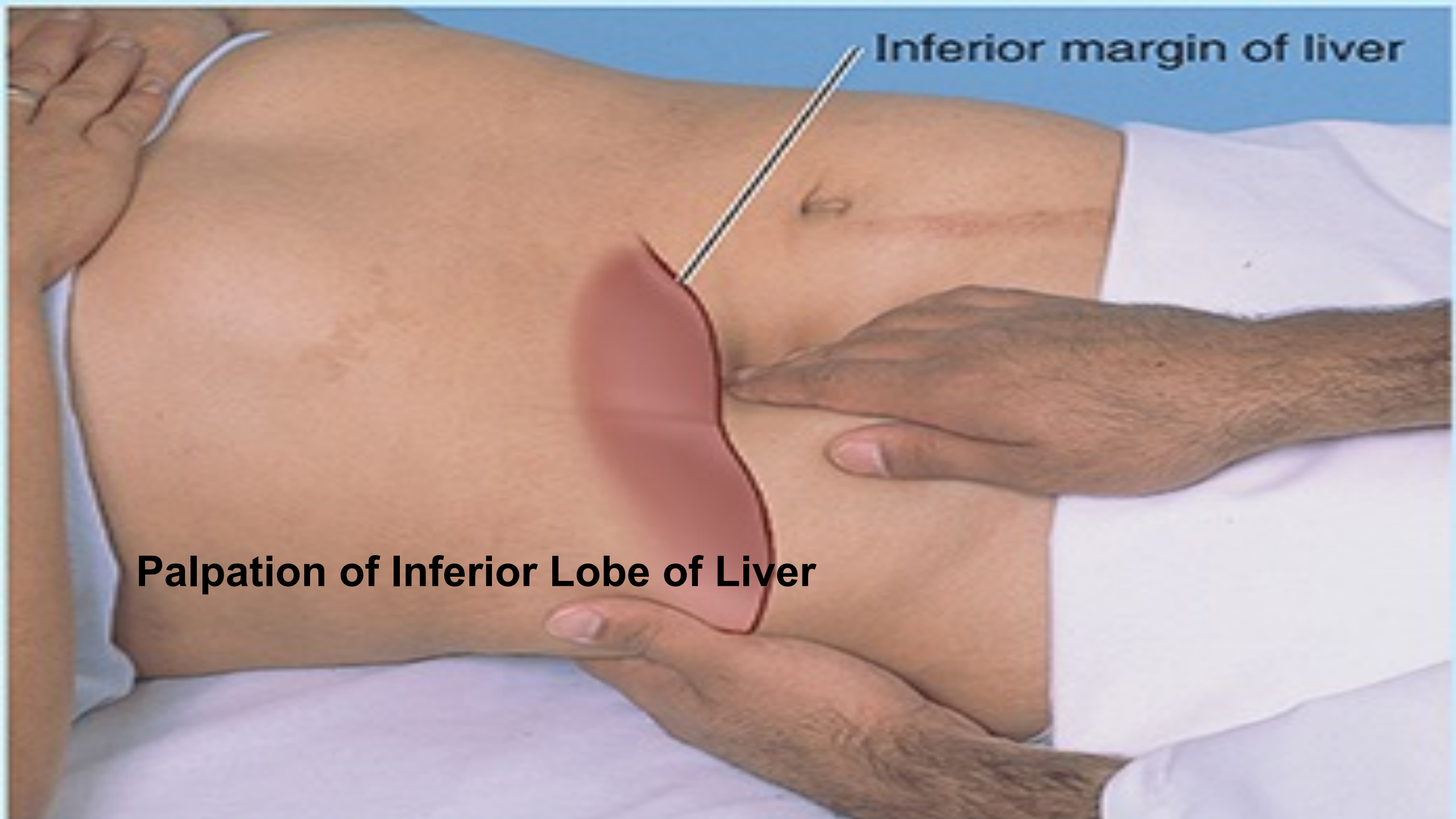
# Palpation of Liver

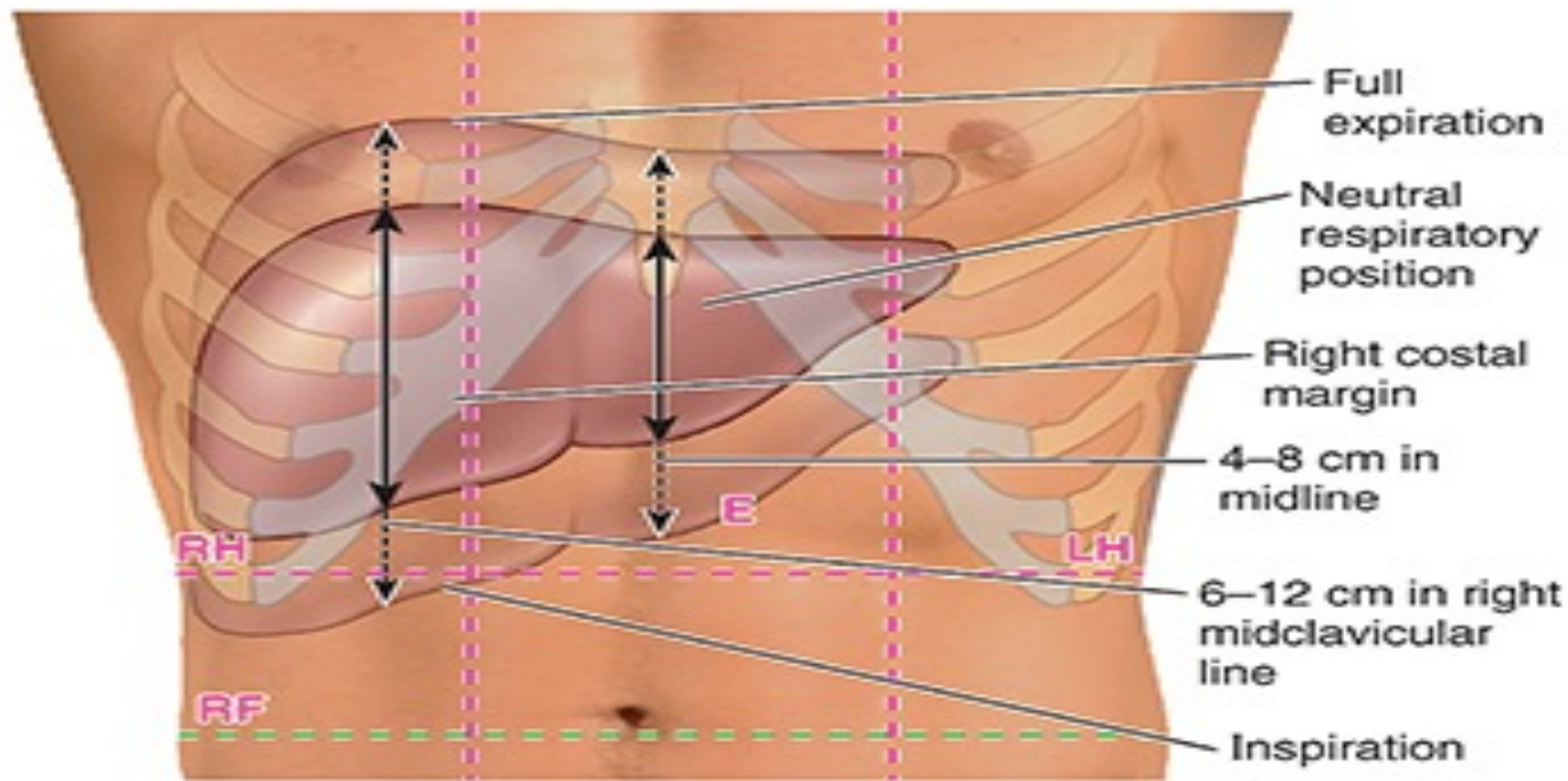
- The liver may be palpated in a supine person because of the inferior movement of the diaphragm and liver that accompanies deep inspiration.
- One method of palpating the liver is to place the left hand posteriorly behind the lower rib cage.
- Put the right hand on the person's right upper quadrant, lateral to the rectus abdominis and inferior to the costal margin.
- The person is asked to take a deep breath as the examiner presses posterosuperiorly with the right hand and pulls anteriorly with the left hand.



Inferior margin of liver

Palpation of Inferior Lobe of Liver

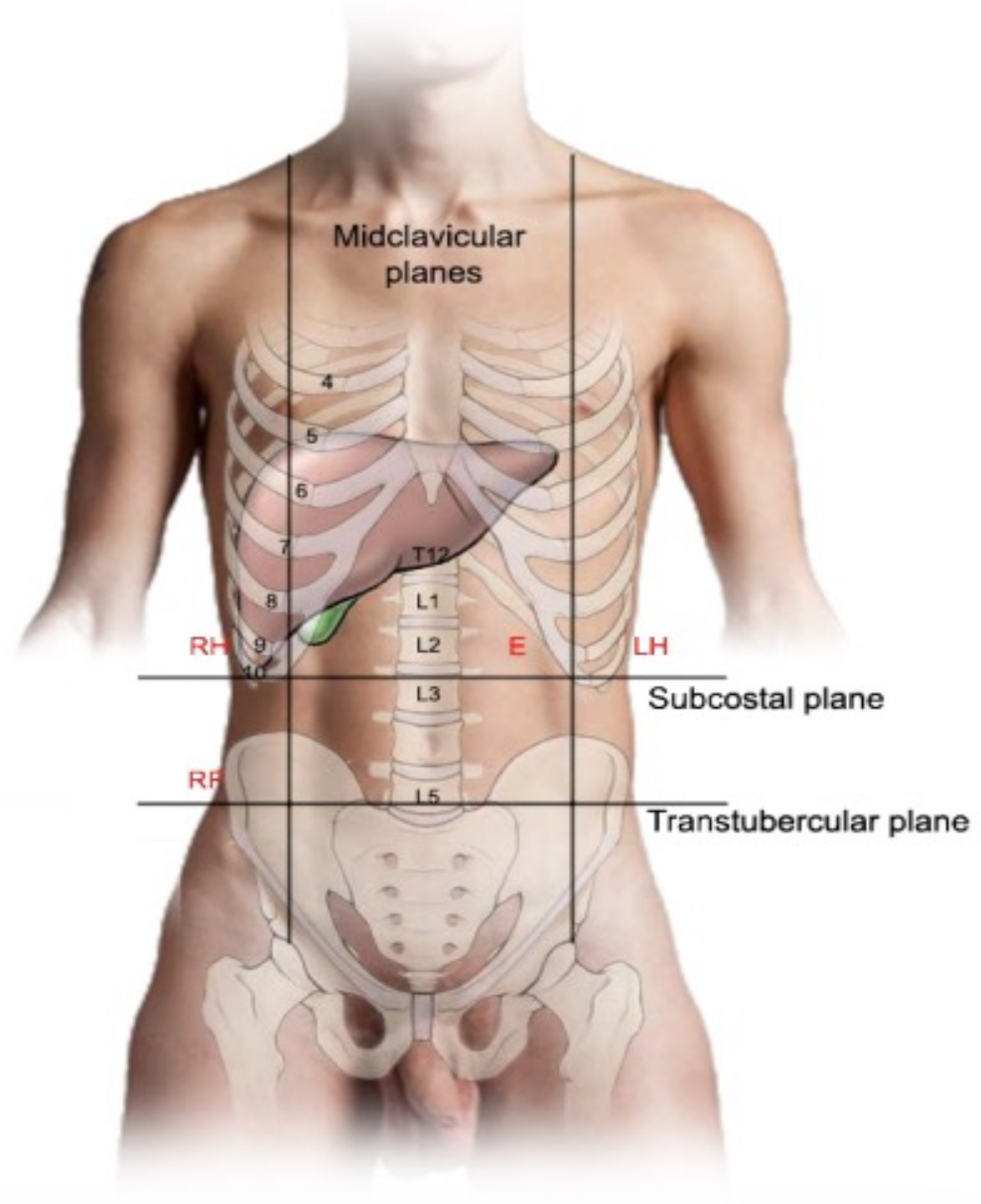




- |           |                                       |           |                     |
|-----------|---------------------------------------|-----------|---------------------|
| <b>E</b>  | Epigastric region                     | <b>RF</b> | Right flank         |
| <b>LH</b> | Left hypochondrium                    | <b>RH</b> | Right hypochondrium |
| ---       | Midclavicular and transpyloric planes |           |                     |
| ---       | Transumbilical plane                  |           |                     |

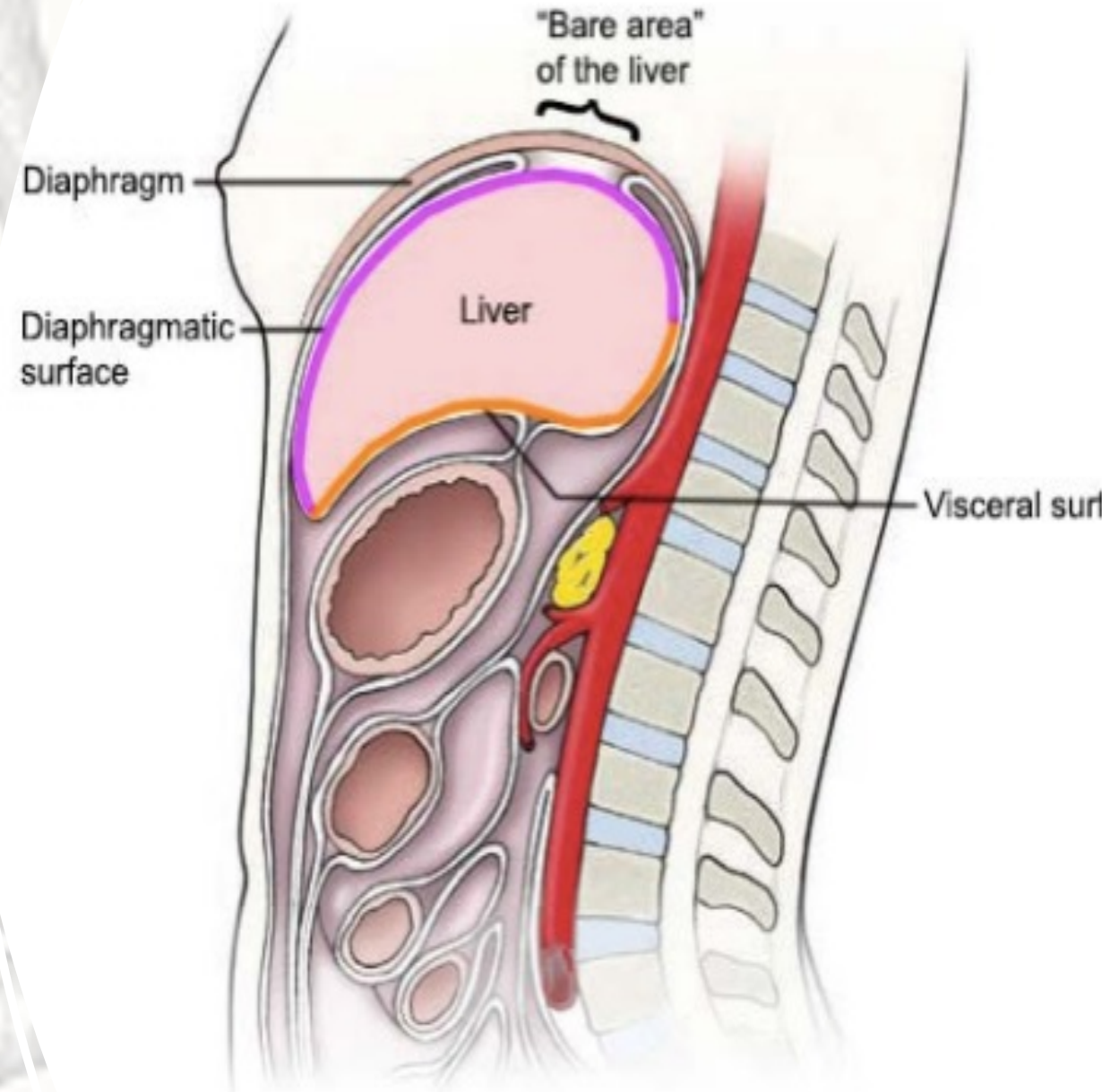
# Surface Projection

- Uppermost: Right midinguinal line
- Right 5th rib
- Right lowermost: Right midaxillary line
- Right 10th costal cartilage
- Left lowermost: Left midinguinal line
- Left 5th intercostal space (ICS)

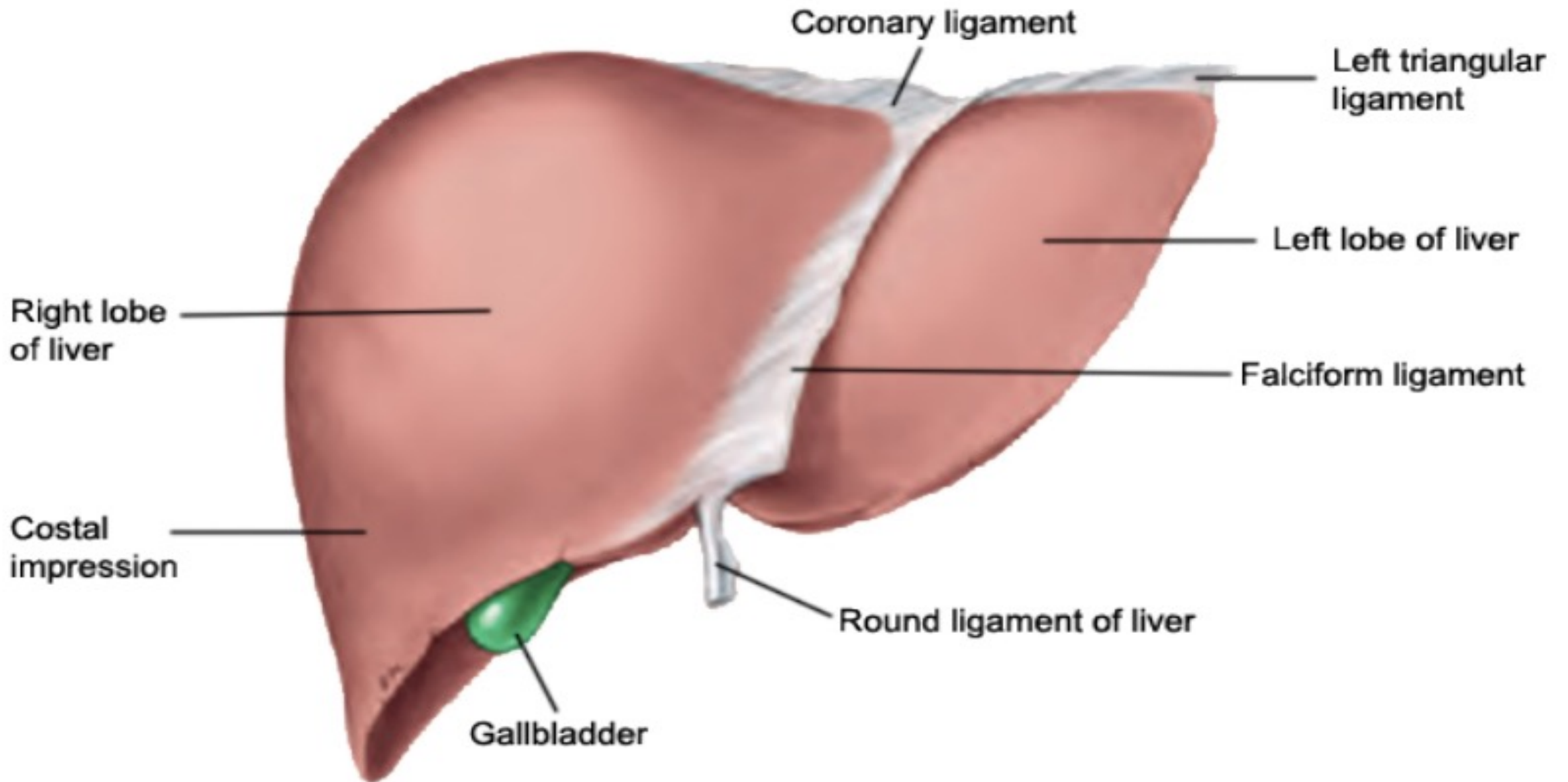


# Surface of the Liver

- **Diaphragmatic surface**
  - Anterosuperior surface
  - Convex surface
  - Relate to inferior surface of diaphragm
- **Visceral surface**
  - Posteroinferior surface
  - Concave surface
  - Relate to abdominal organ



# Diaphragmatic Surface



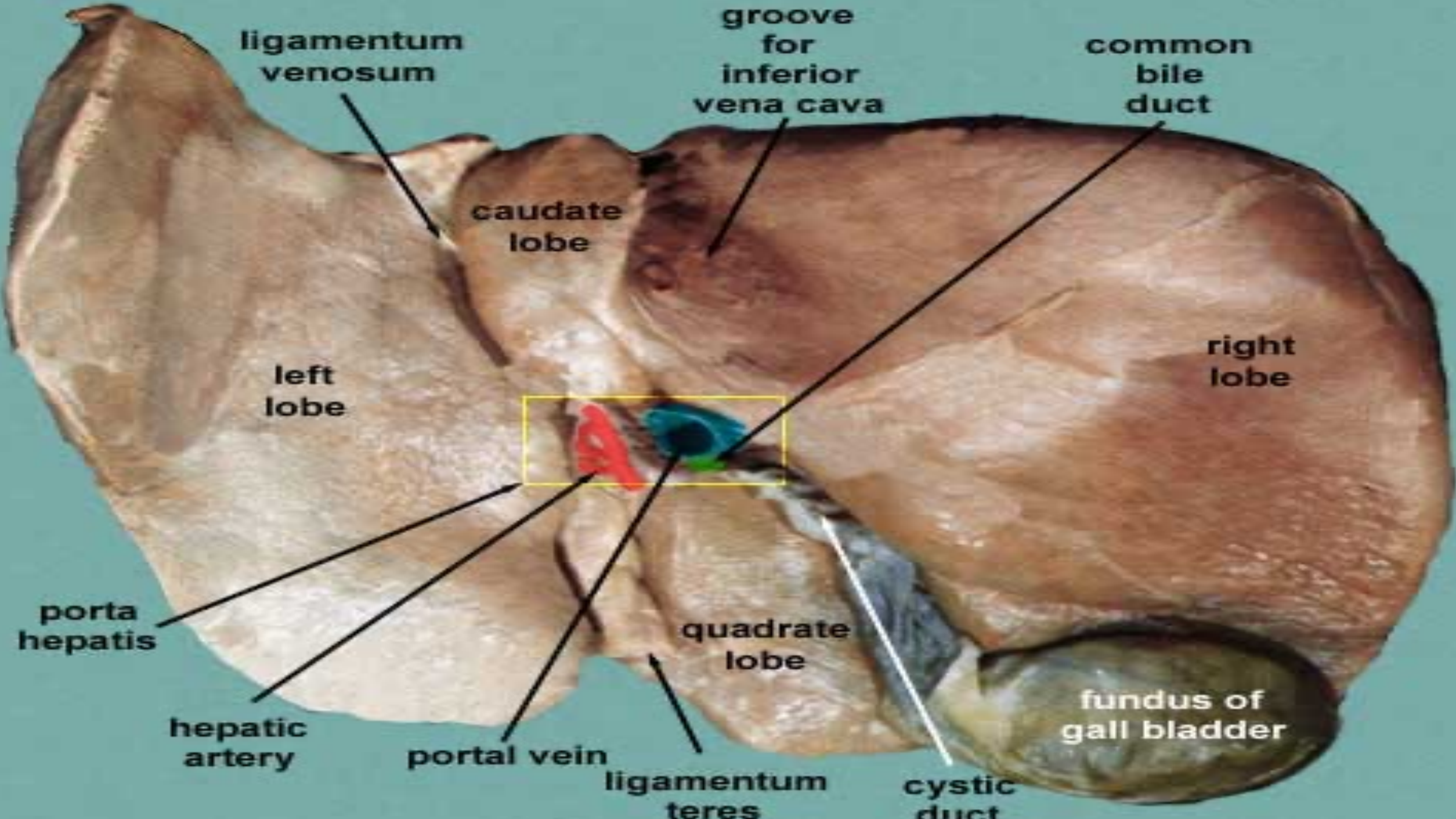
# Visceral Surface of the Liver

- Porta hepatis – Hepatic artery, Portal vein, Bile duct, Nerves and Lymphatic vessels
  - Similar to hilum of lungs and kidneys
- Ligamentum teres hepatis (round ligament of liver)
  - Remnant of umbilical vein
- Ligamentum venosum
  - Remnant of ductus venosus
- Gallbladder
- Inferior vena cava

Gall  
Bladder  
Inferior  
vena  
cava  
flexure

Pancreas

Spleno  
flexure



ligamentum venosum

groove for inferior vena cava

common bile duct

caudate lobe

left lobe

right lobe

porta hepatis

hepatic artery

portal vein

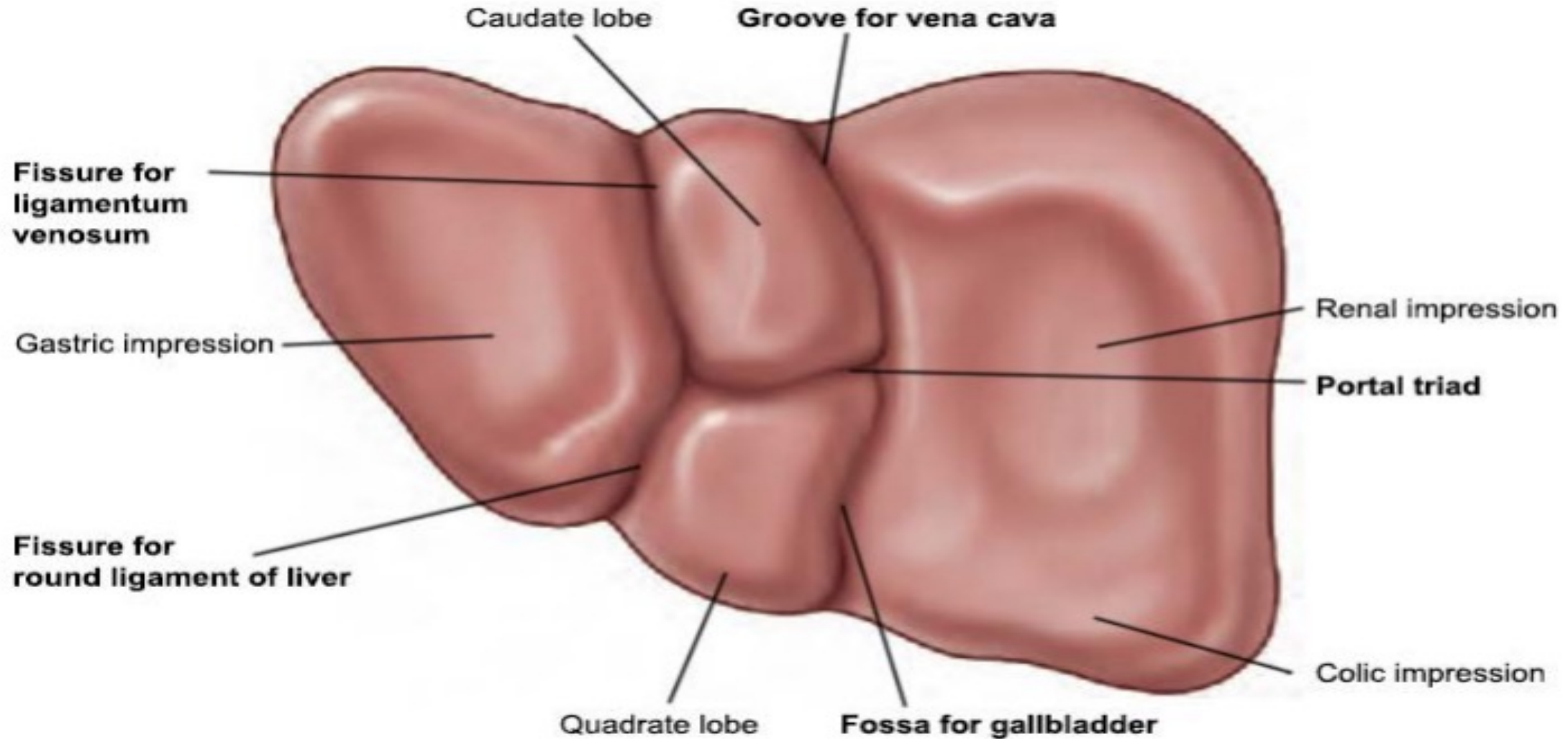
quadratus lobe

fundus of gall bladder

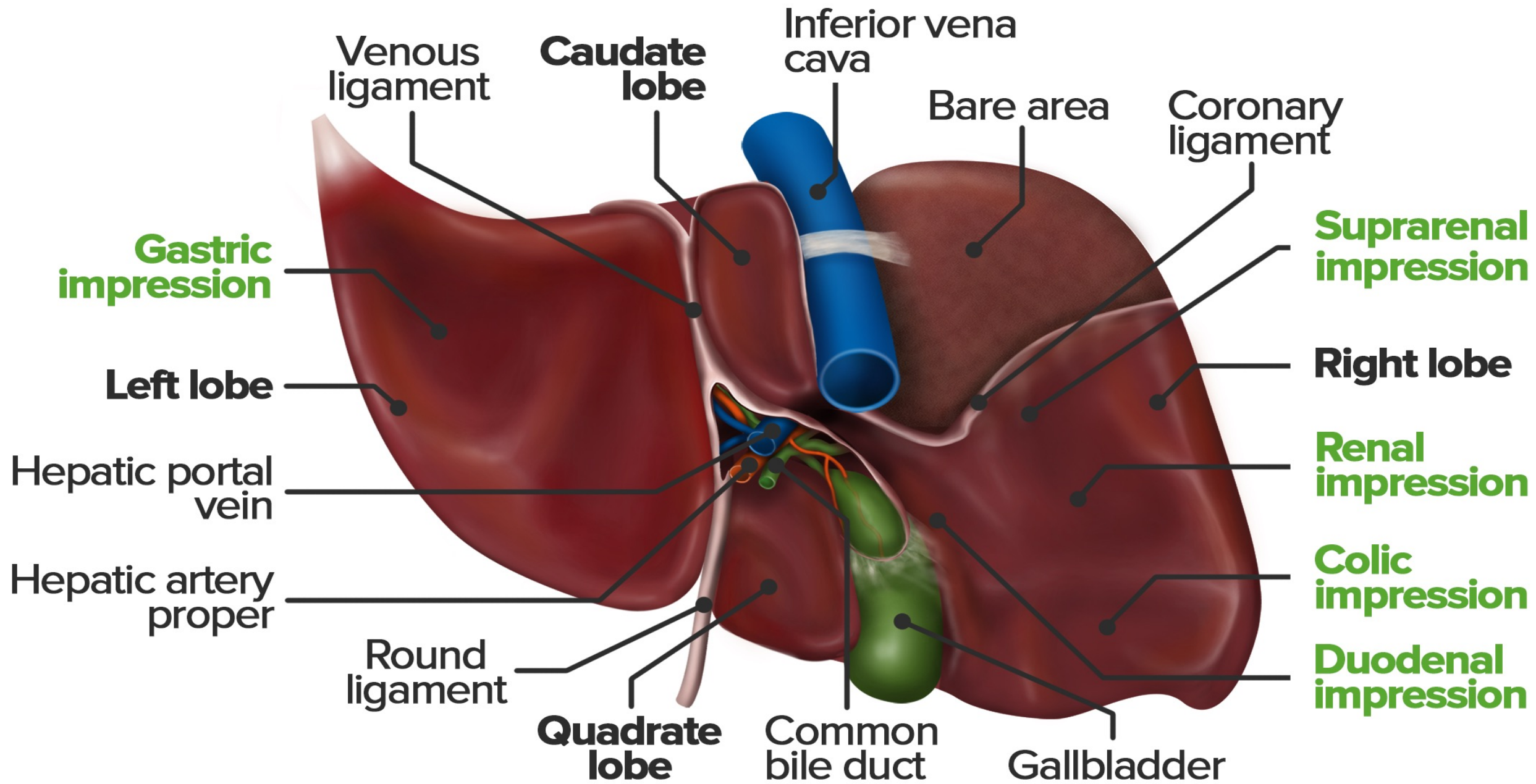
ligamentum teres

cystic duct

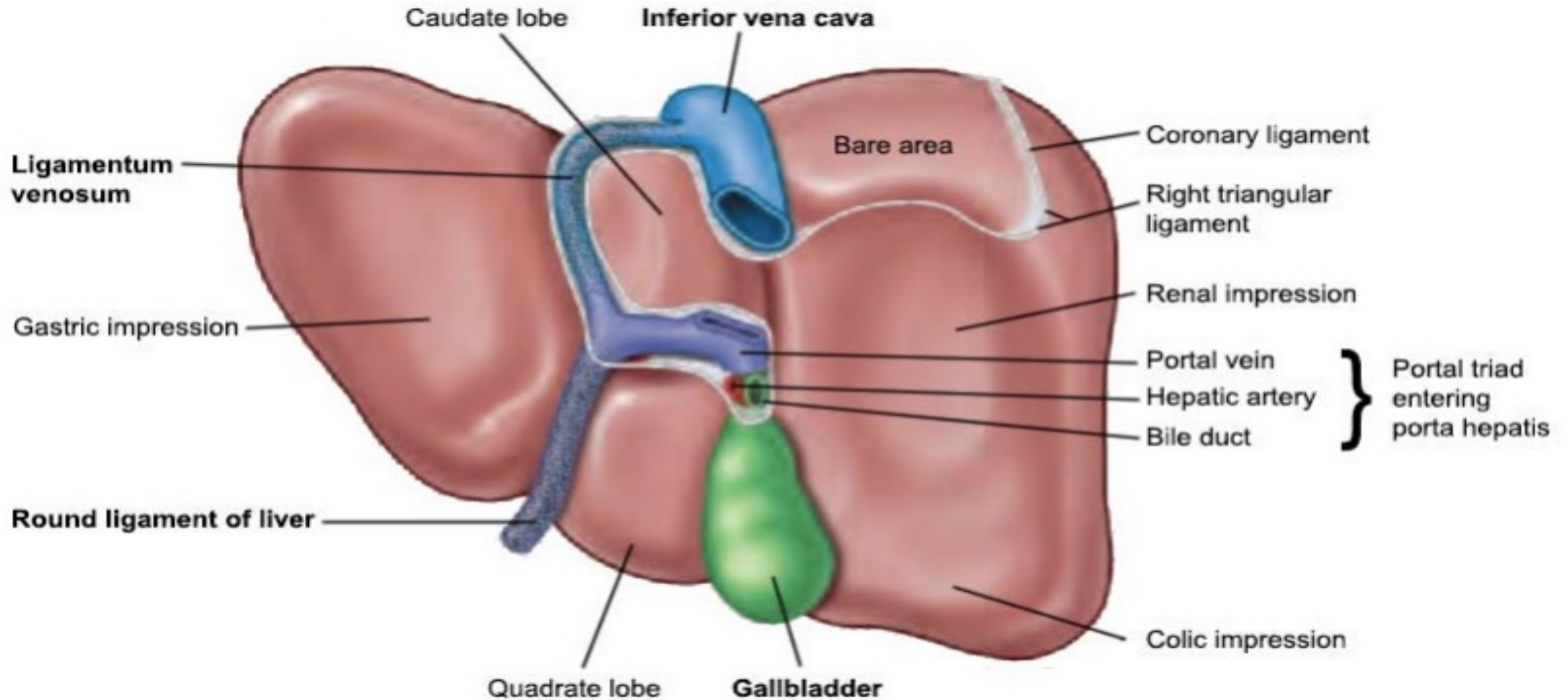
# Visceral Surface of the Liver



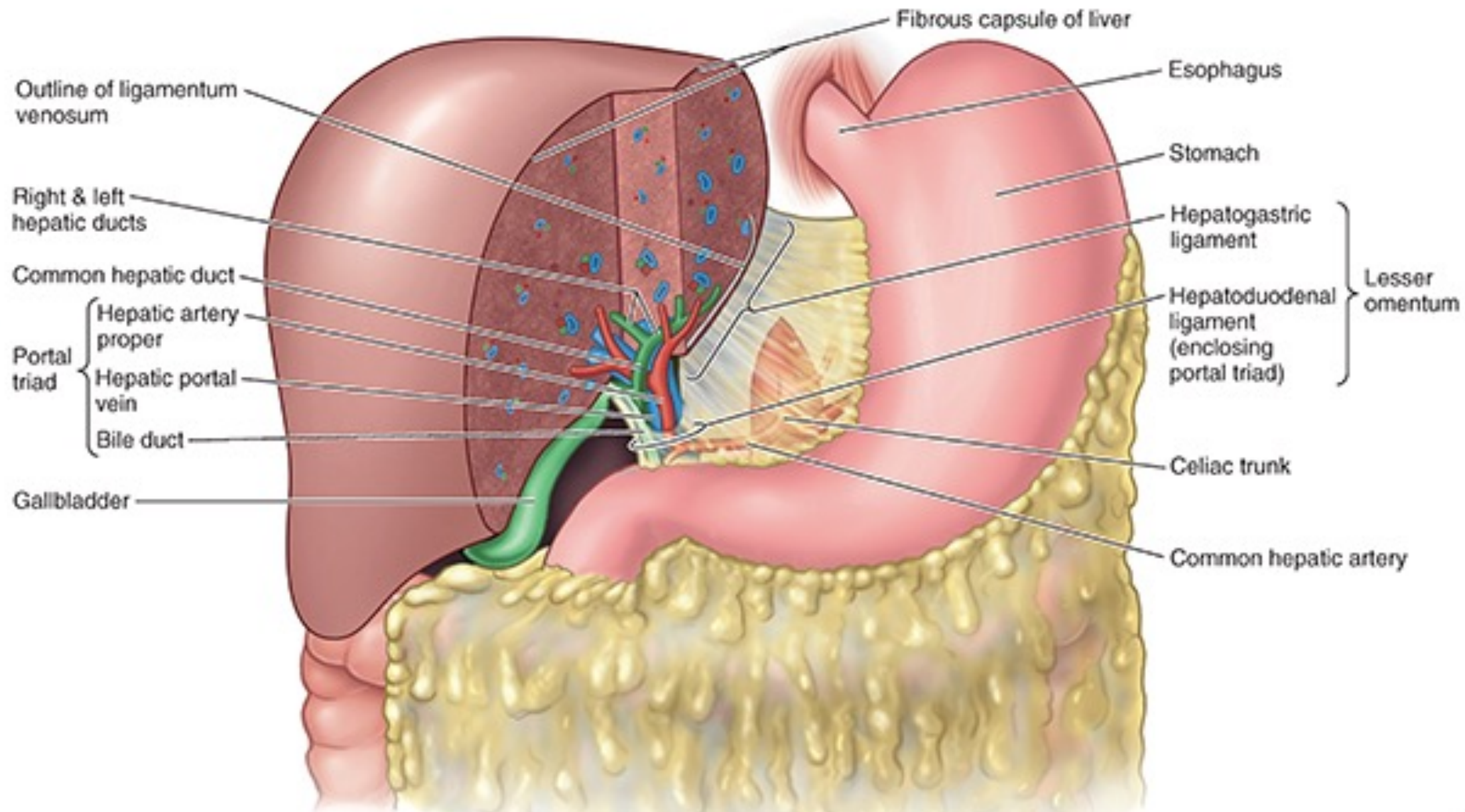




# Visceral Surface of the Liver

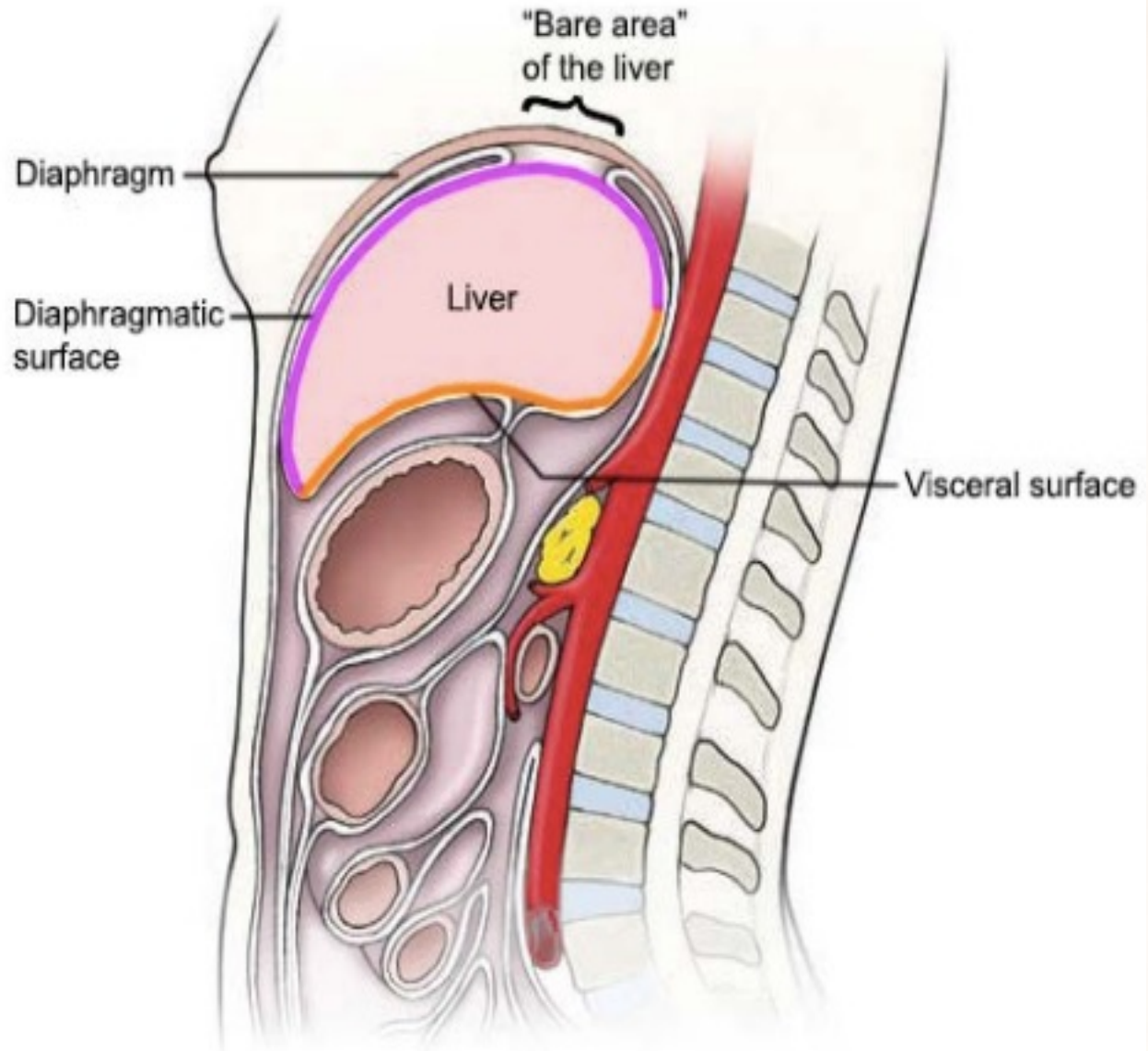


# The Lesser Omentum



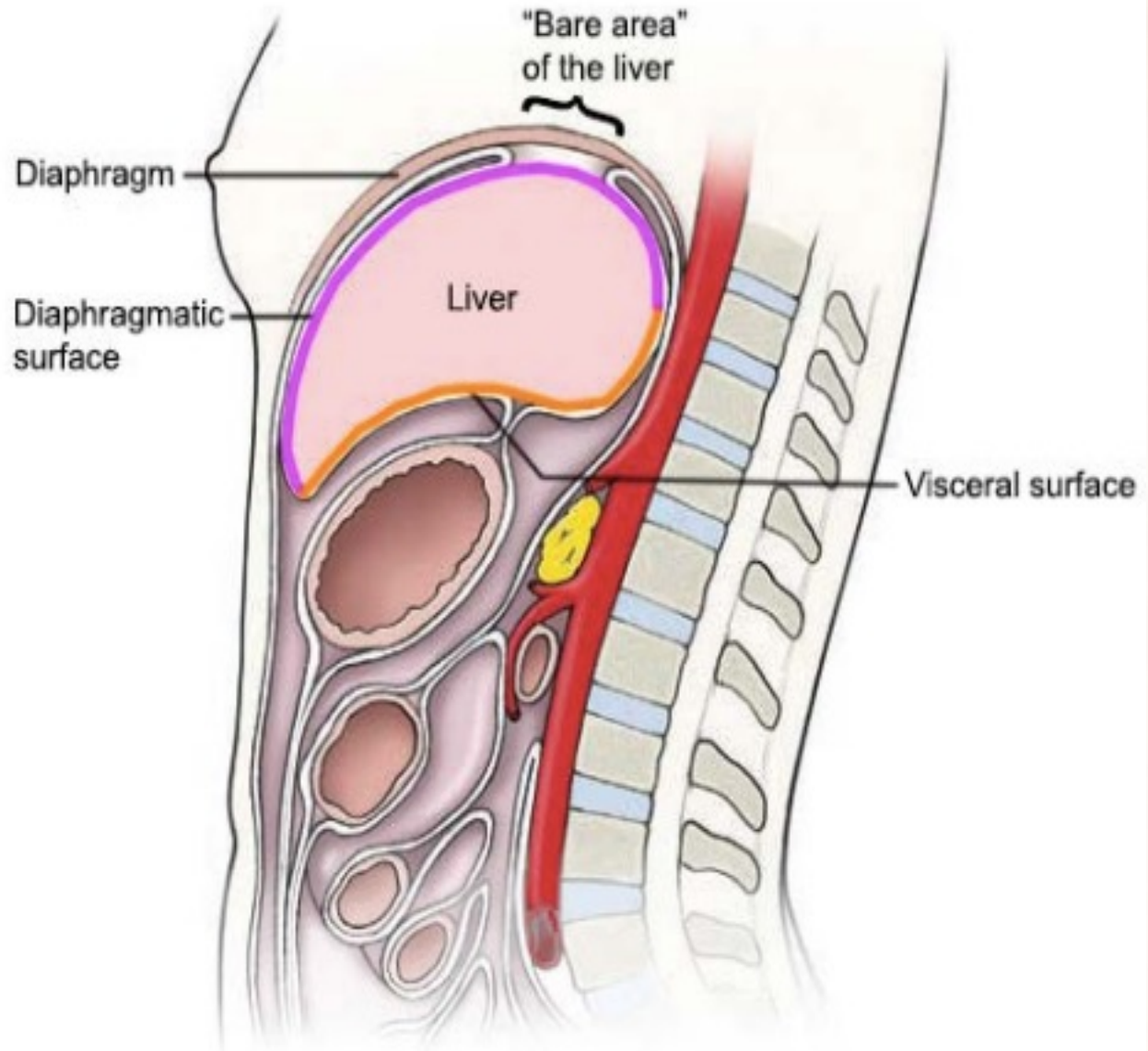
# Peritoneal Relationships

- “Glisson’s capsule”
  - Capsule of the liver
  - Dense layer of fibrous connective tissue
  - A layer of connective tissue surrounding the liver and ensheathing the hepatic artery, portal vein, and bile ducts within the liver.



# Peritoneal Relationships

- “Visceral peritoneum covers the liver, except “bare areas”
- The attachment site of the liver to the right diaphragm is known as the bare area.
- The liver surface under the bare area is thought to lack a peritoneal covering in adults



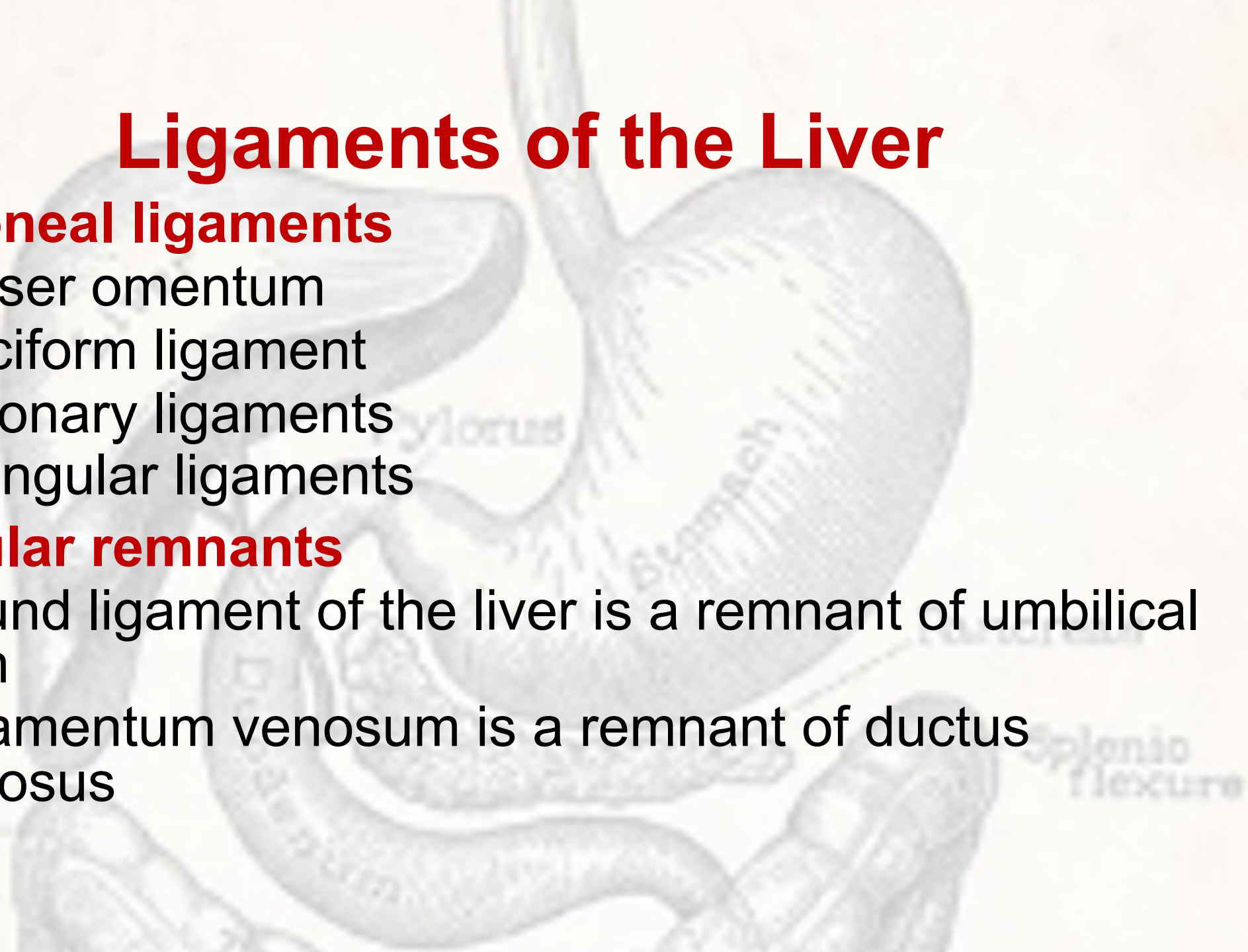
# Ligaments of the Liver

- **Peritoneal ligaments**

- Lesser omentum
- Falciform ligament
- Coronary ligaments
- Triangular ligaments

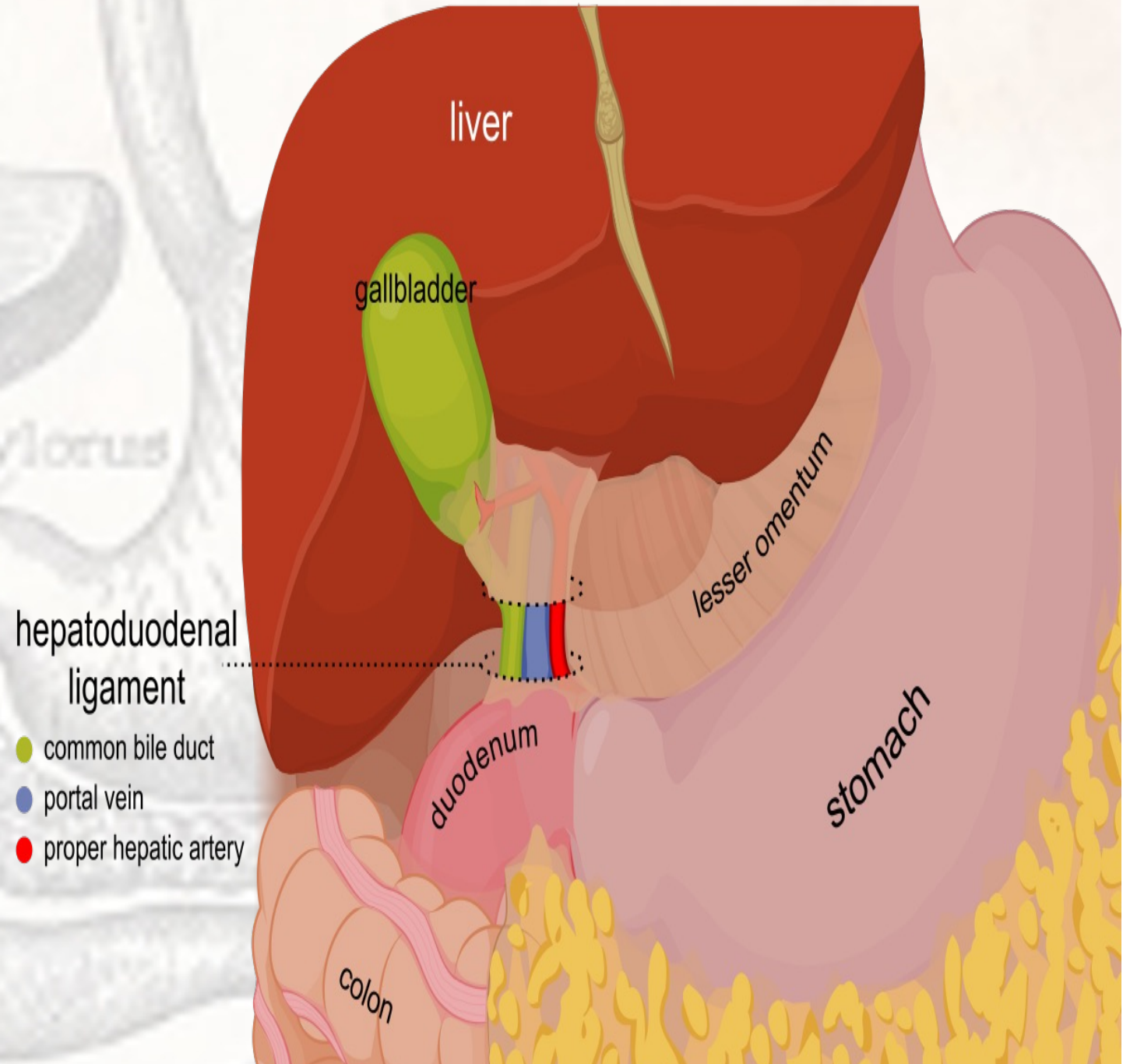
- **Vascular remnants**

- Round ligament of the liver is a remnant of umbilical vein
- Ligamentum venosum is a remnant of ductus venosus



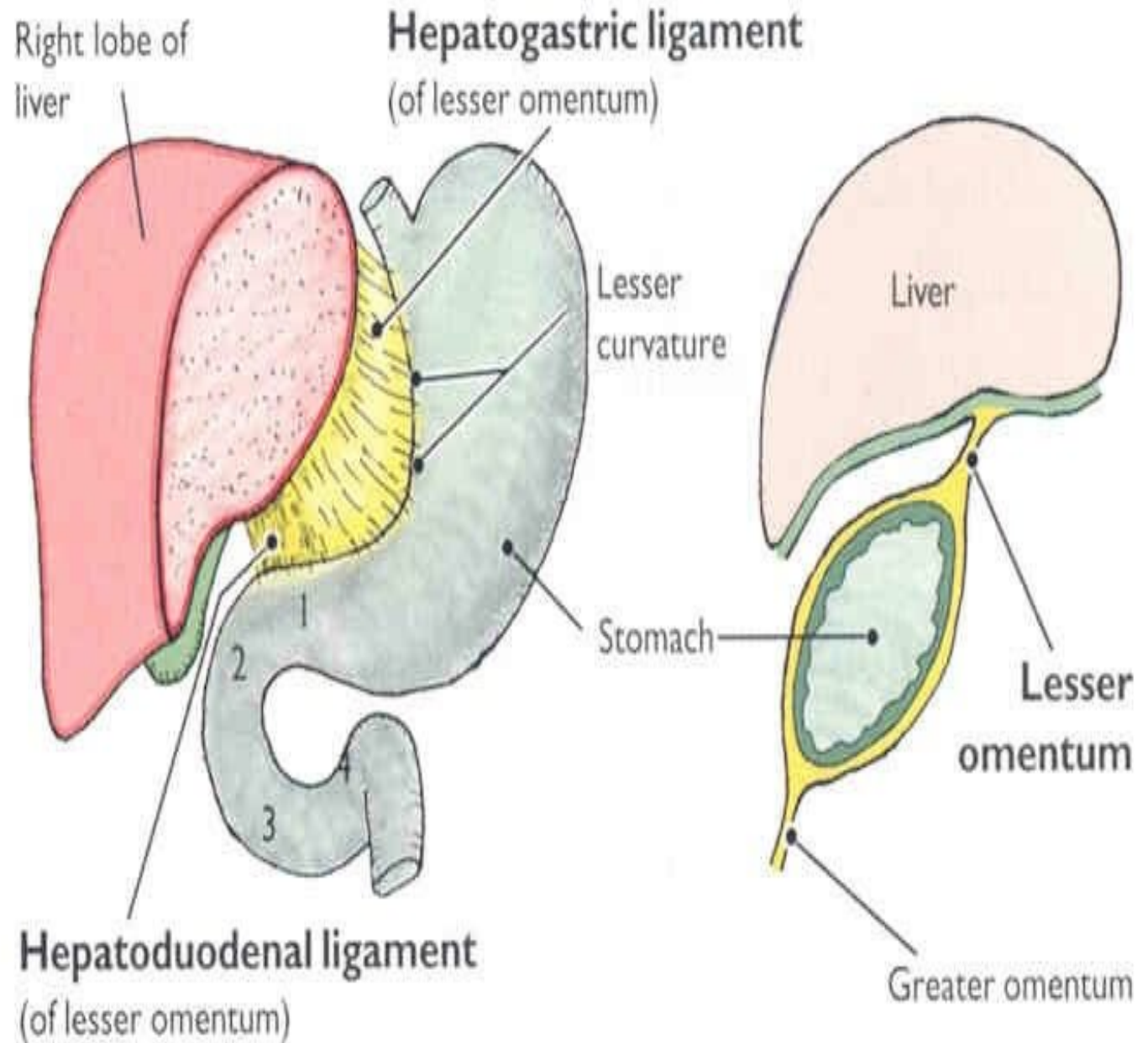
# Lesser Omentum

- **Hepatoduodenal ligament**
- It connects the porta hepatis of the liver to the upper border of the first part of the duodenum.
- Enclosing portal triad
  - Common bile duct
  - Portal vein
  - Hepatic artery



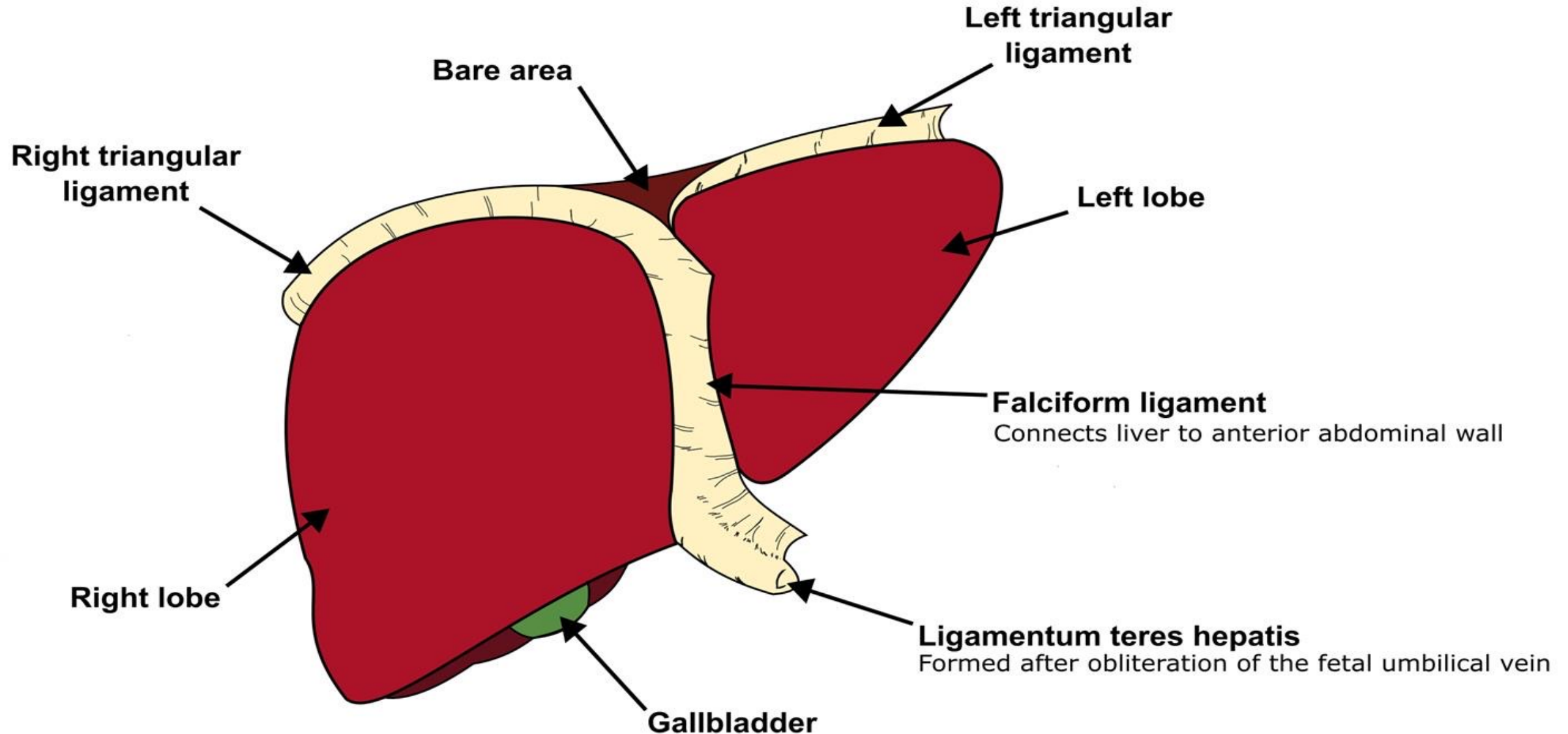
# Lesser Omentum

- Hepatogastric ligament or Gastrohepatic ligament
  - Connects the liver to the lesser curvature of the stomach.
  - It contains the right and the left gastric arteries



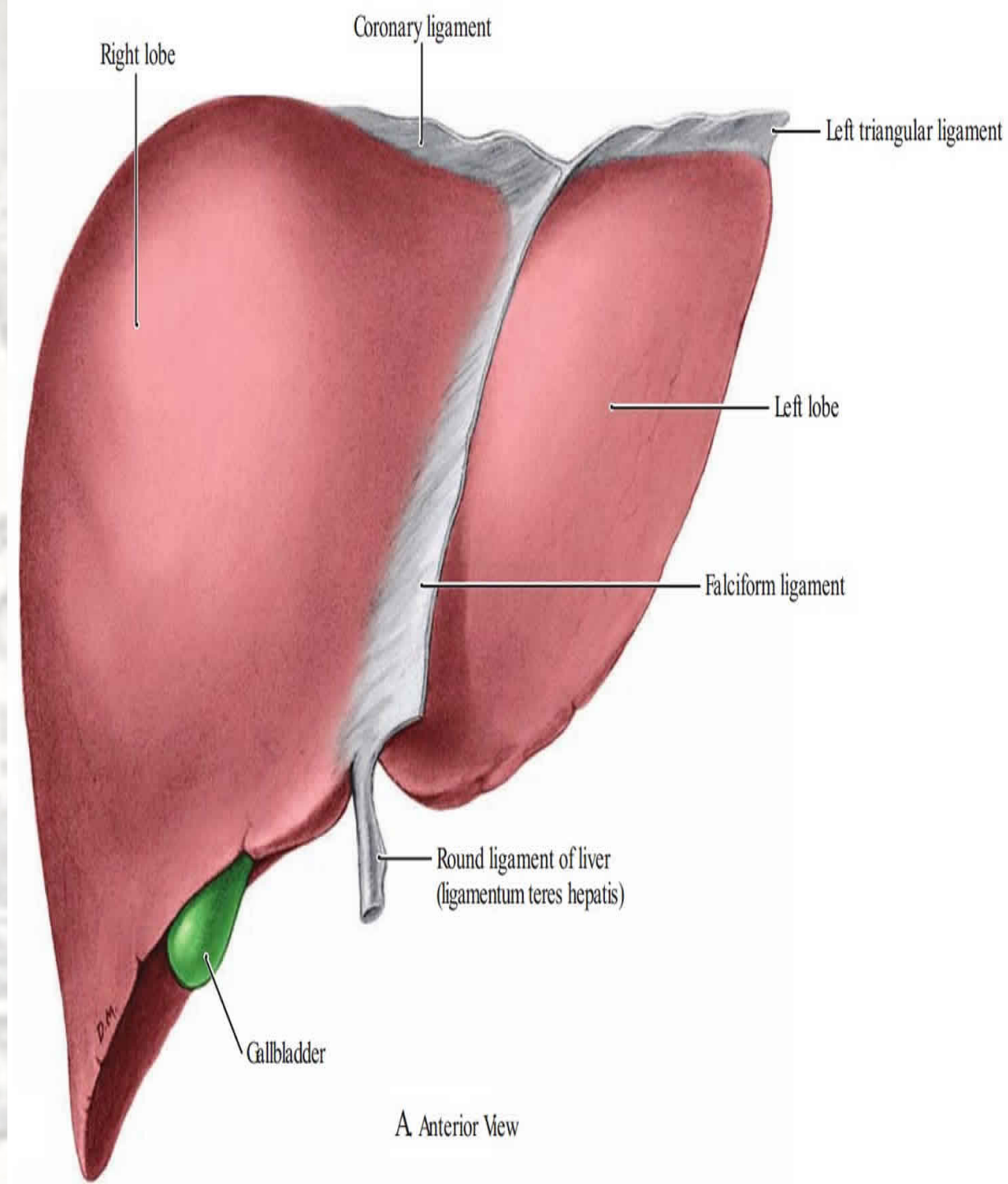


# Ligaments of the Liver

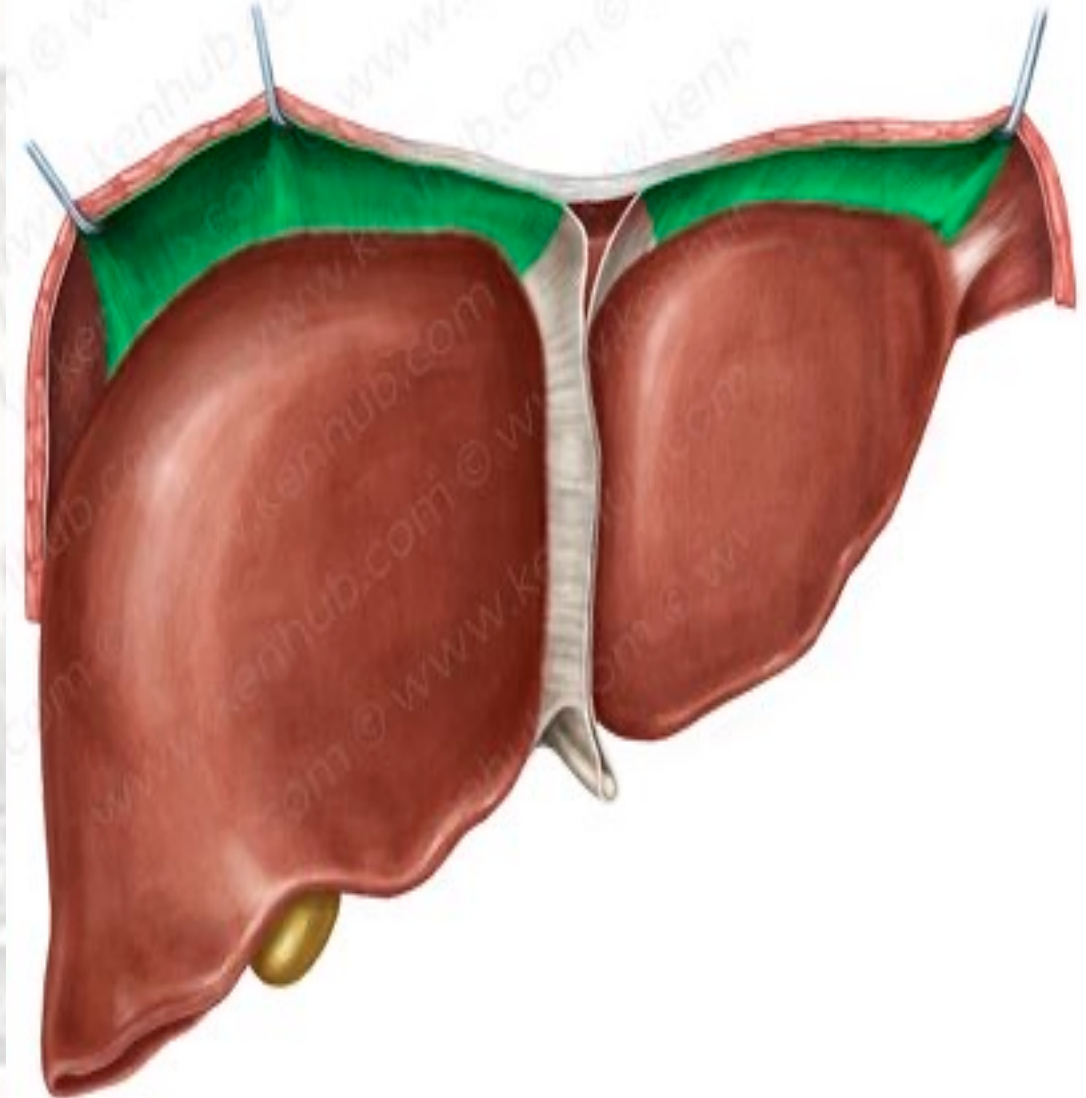


- **Falciform Ligament**

- The falciform ligament (which divides the liver into a larger anatomical right lobe and a smaller anatomical left lobe) has 2 layers of peritoneum
- Attaches the anterior surface of the liver to the anterior abdominal wall.
- Its contains the ligamentum teres, a remnant of the umbilical vein



- **Coronary Ligament** (anterior and posterior folds)
  - Attaches the superior surface of the liver to the inferior surface of the diaphragm and demarcates the bare area of the liver.
  - The anterior and posterior folds unite to form the triangular ligaments on the right and left lobes of the liver.



- **Triangular ligaments (left and right)**

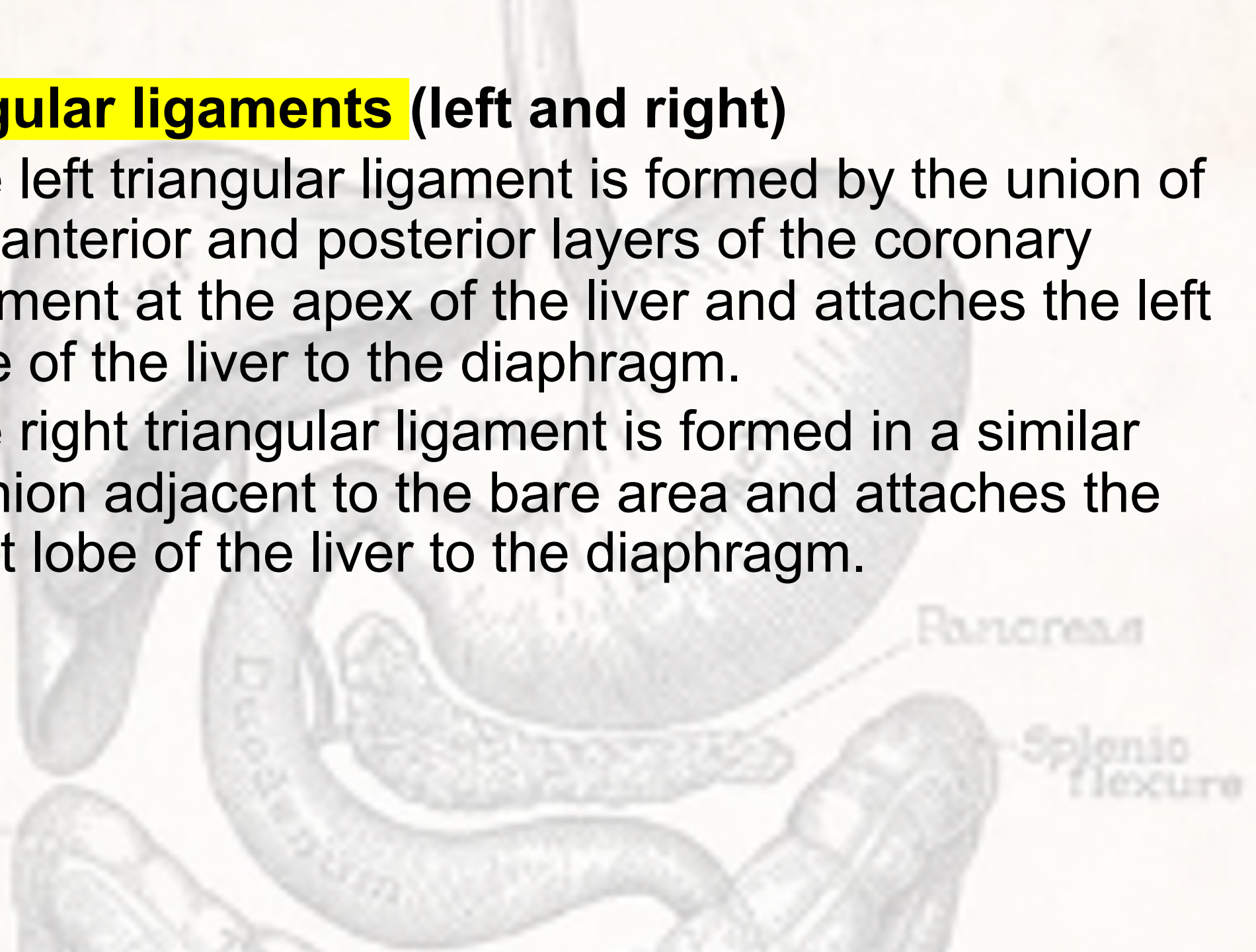
- The left triangular ligament is formed by the union of the anterior and posterior layers of the coronary ligament at the apex of the liver and attaches the left lobe of the liver to the diaphragm.
- The right triangular ligament is formed in a similar fashion adjacent to the bare area and attaches the right lobe of the liver to the diaphragm.

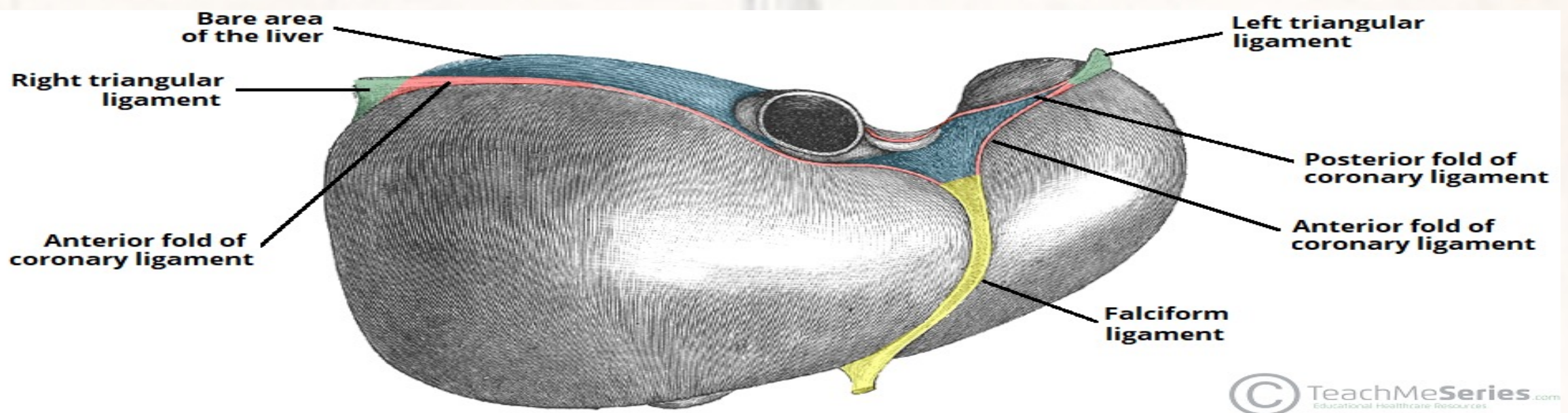
Gall  
Bladder

Pancreas

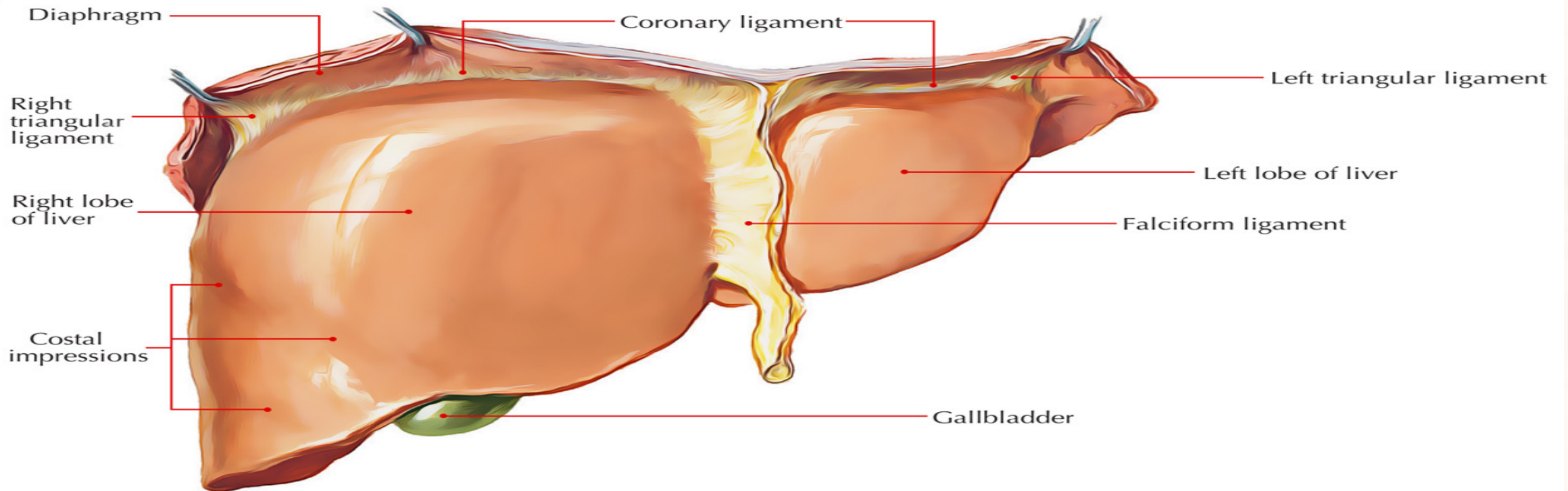
Spleno  
flexure

Hepatic  
flexure





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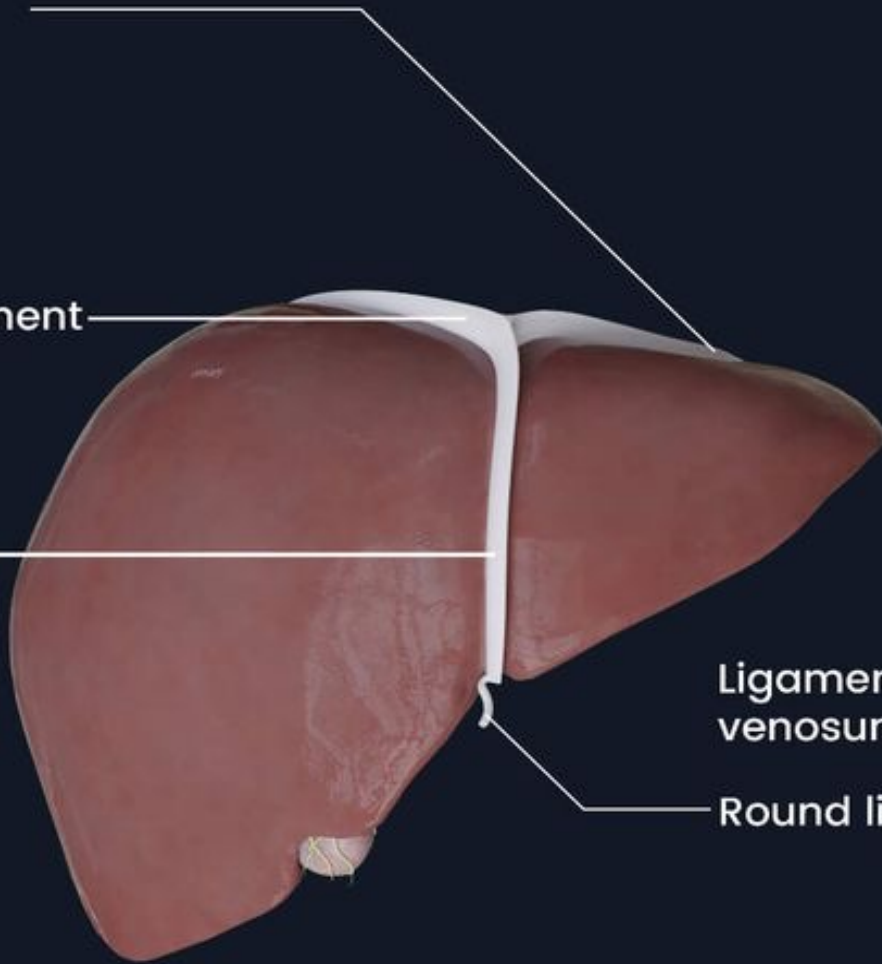
- **Lesser Omentum**

- Attaches the liver to the lesser curvature of the stomach and first part of the duodenum.
- It consists of the hepatoduodenal ligament (extends from the duodenum to the liver) and the hepatogastric ligament (extends from the stomach to the liver).
- The hepatoduodenal ligament surrounds the portal triad.
- In addition to these supporting ligaments, the posterior surface of the liver is secured to the inferior vena cava by hepatic veins and fibrous tissue.

Left triangular ligament

Coronary ligament

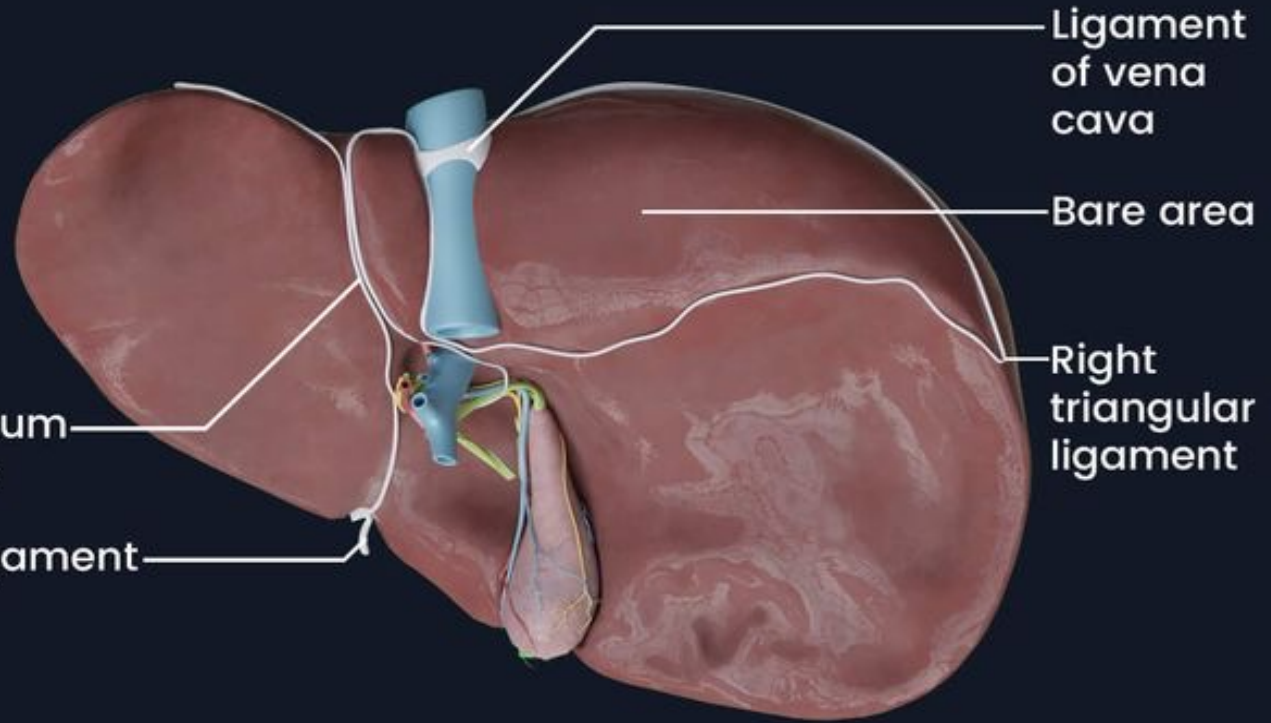
Falciform ligament



Anterior view

Ligamentum venosum

Round ligament

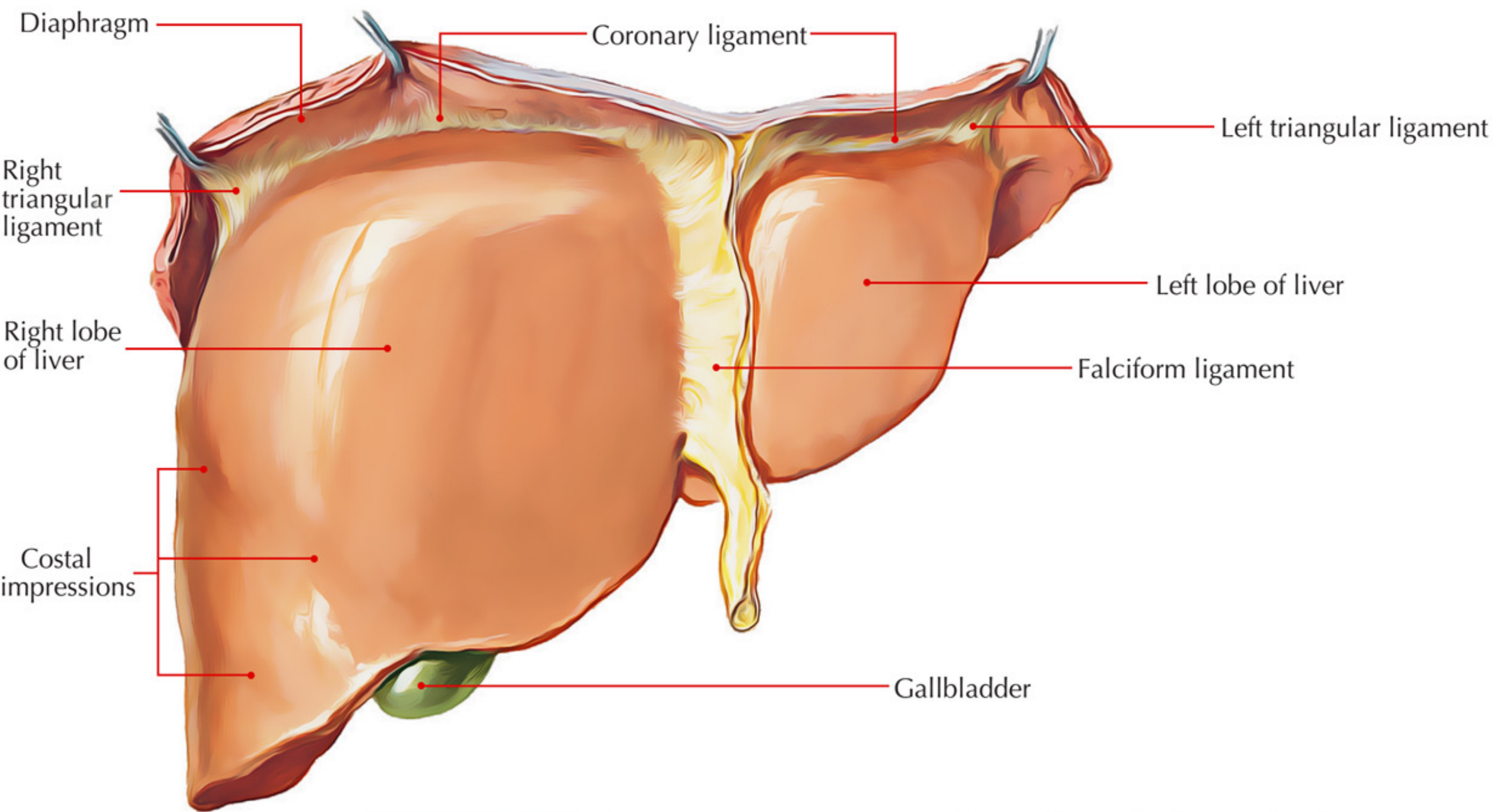


Inferior view

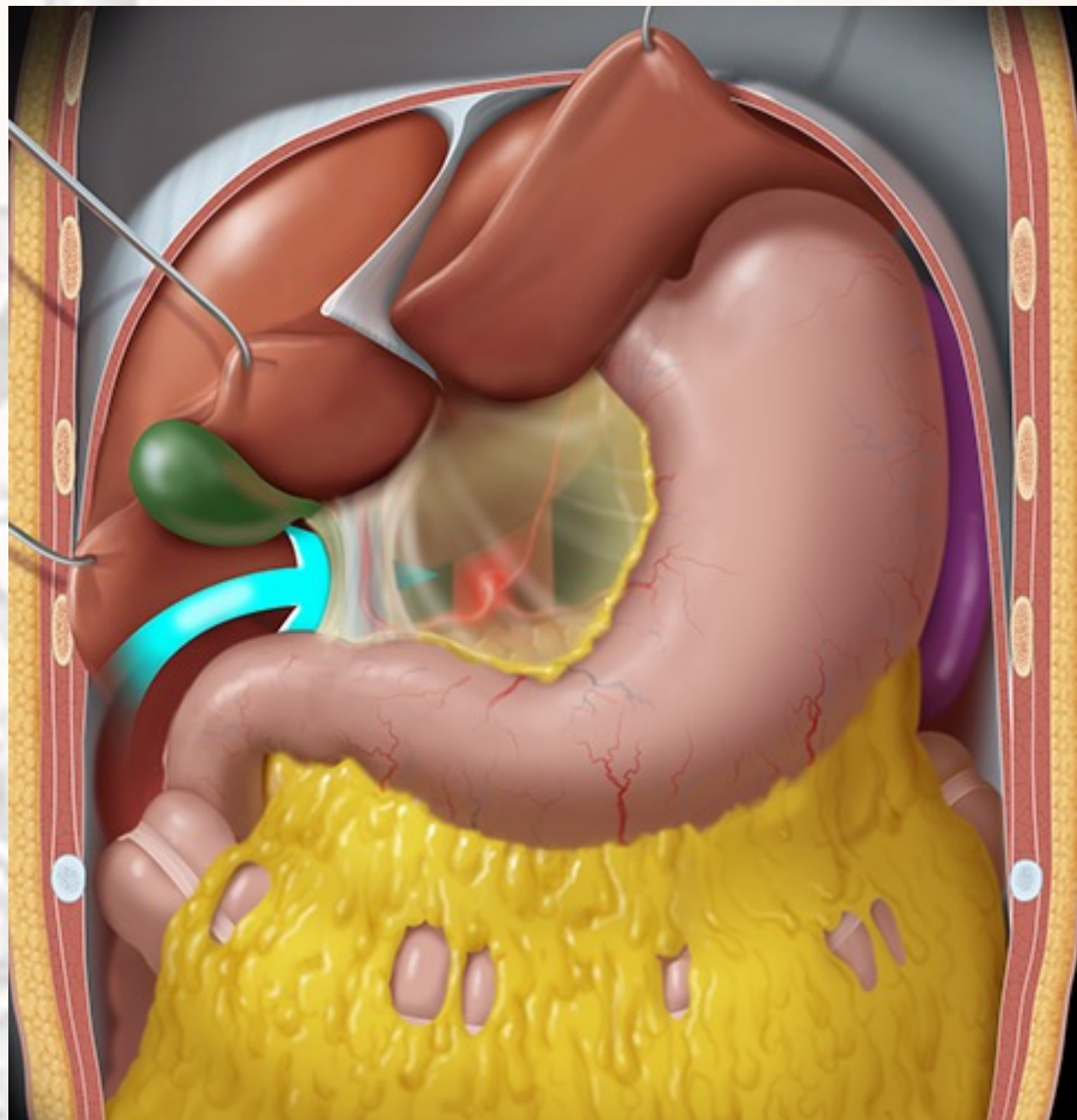
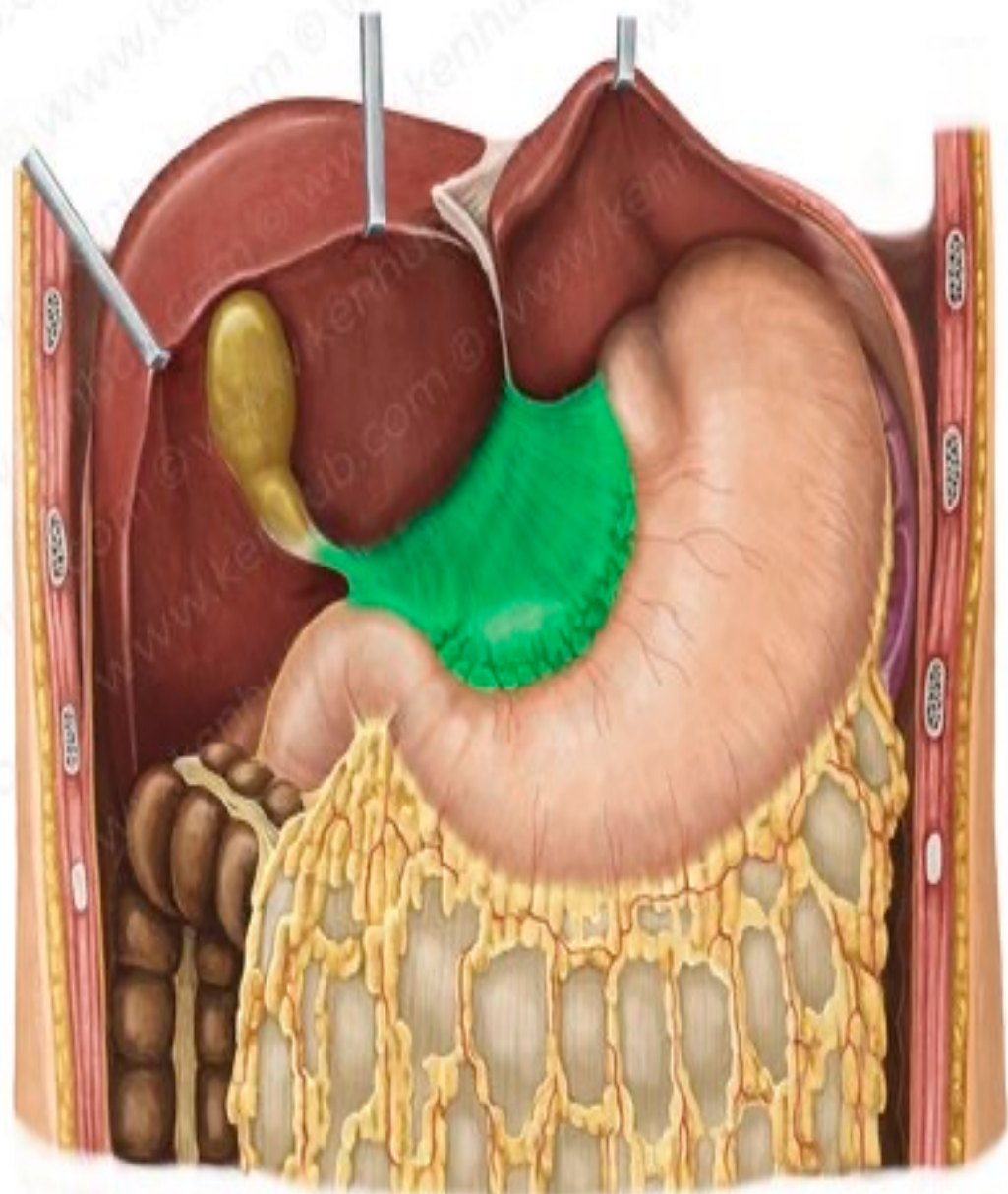
Ligament of vena cava

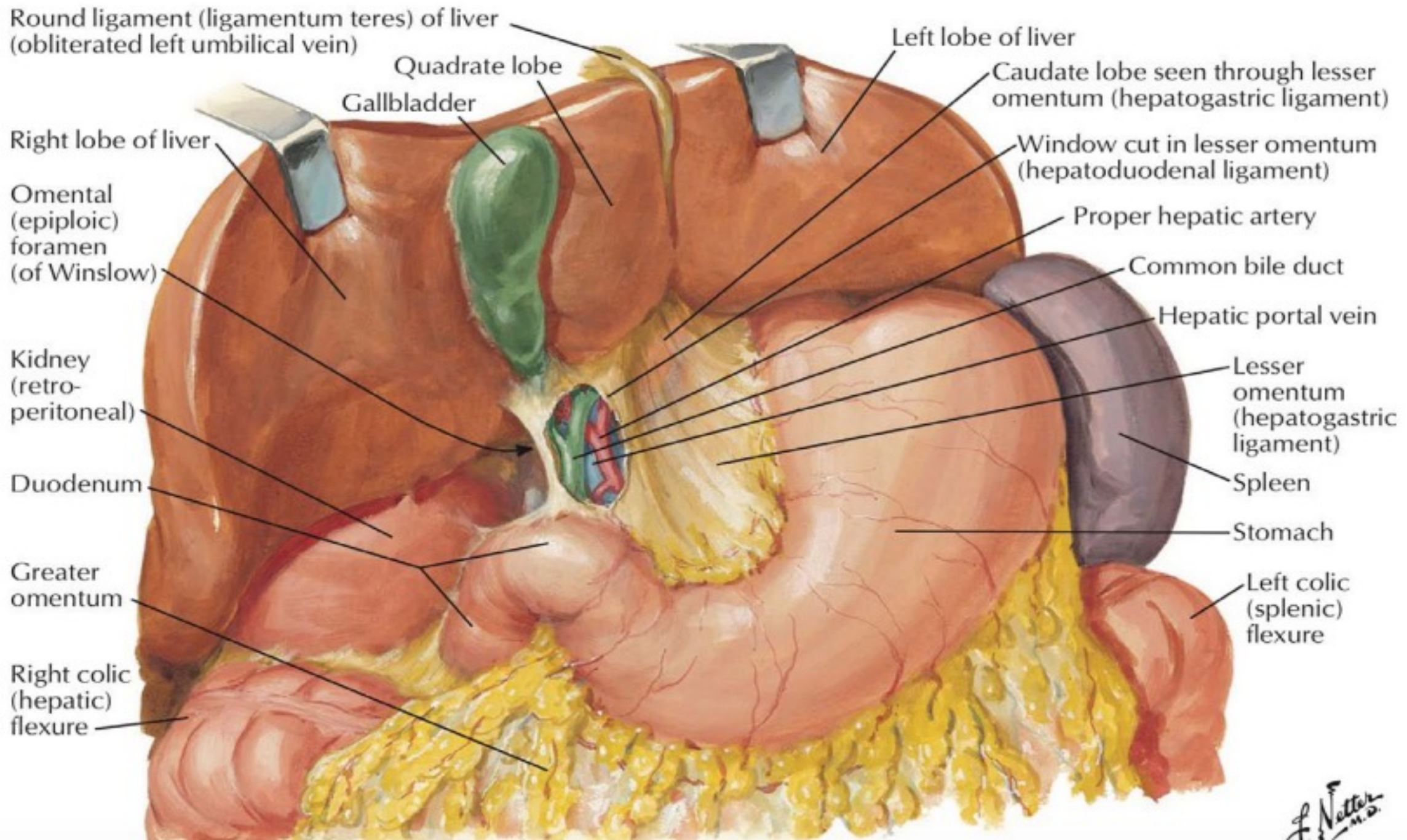
Bare area

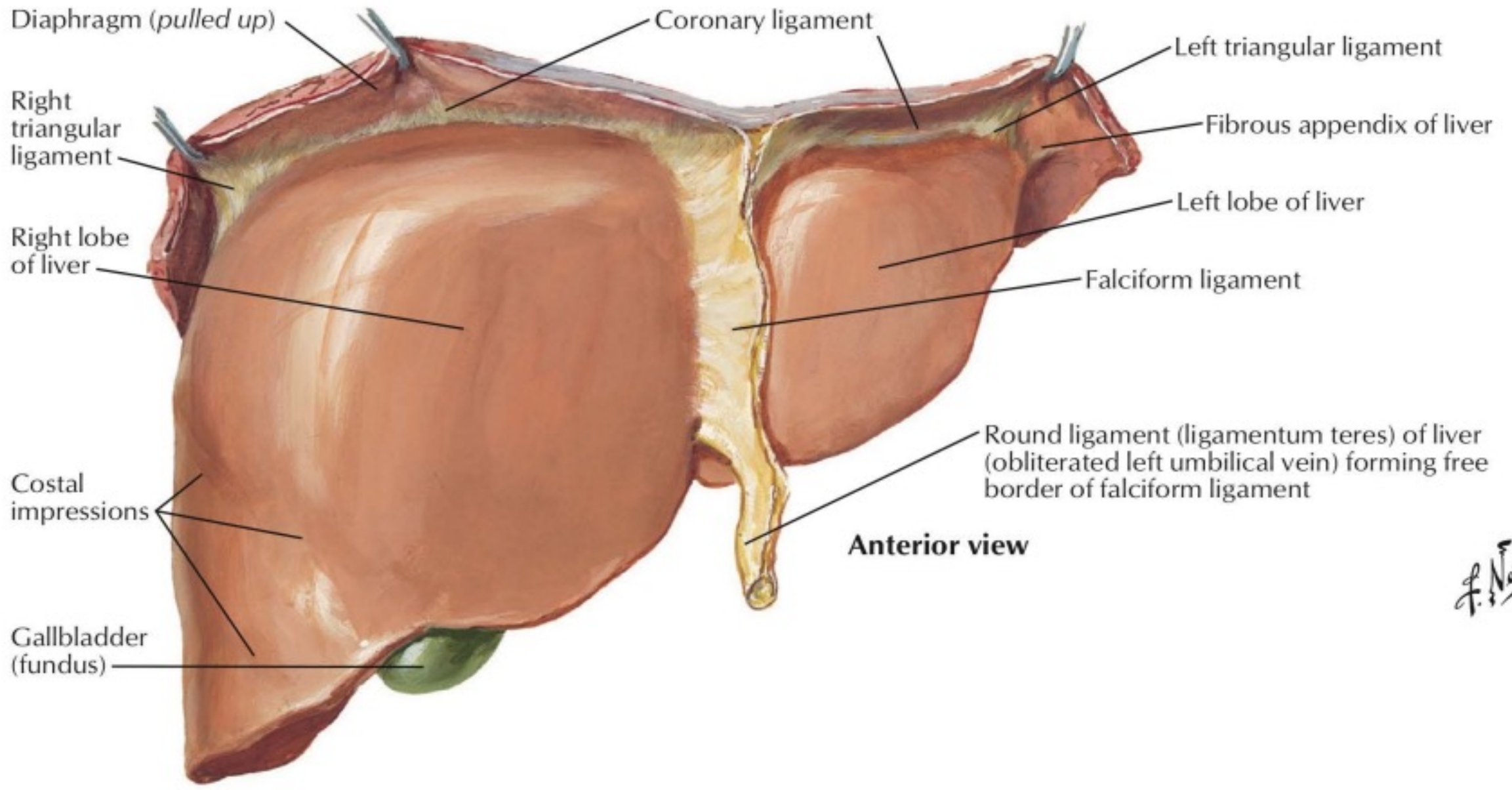
Right triangular ligament



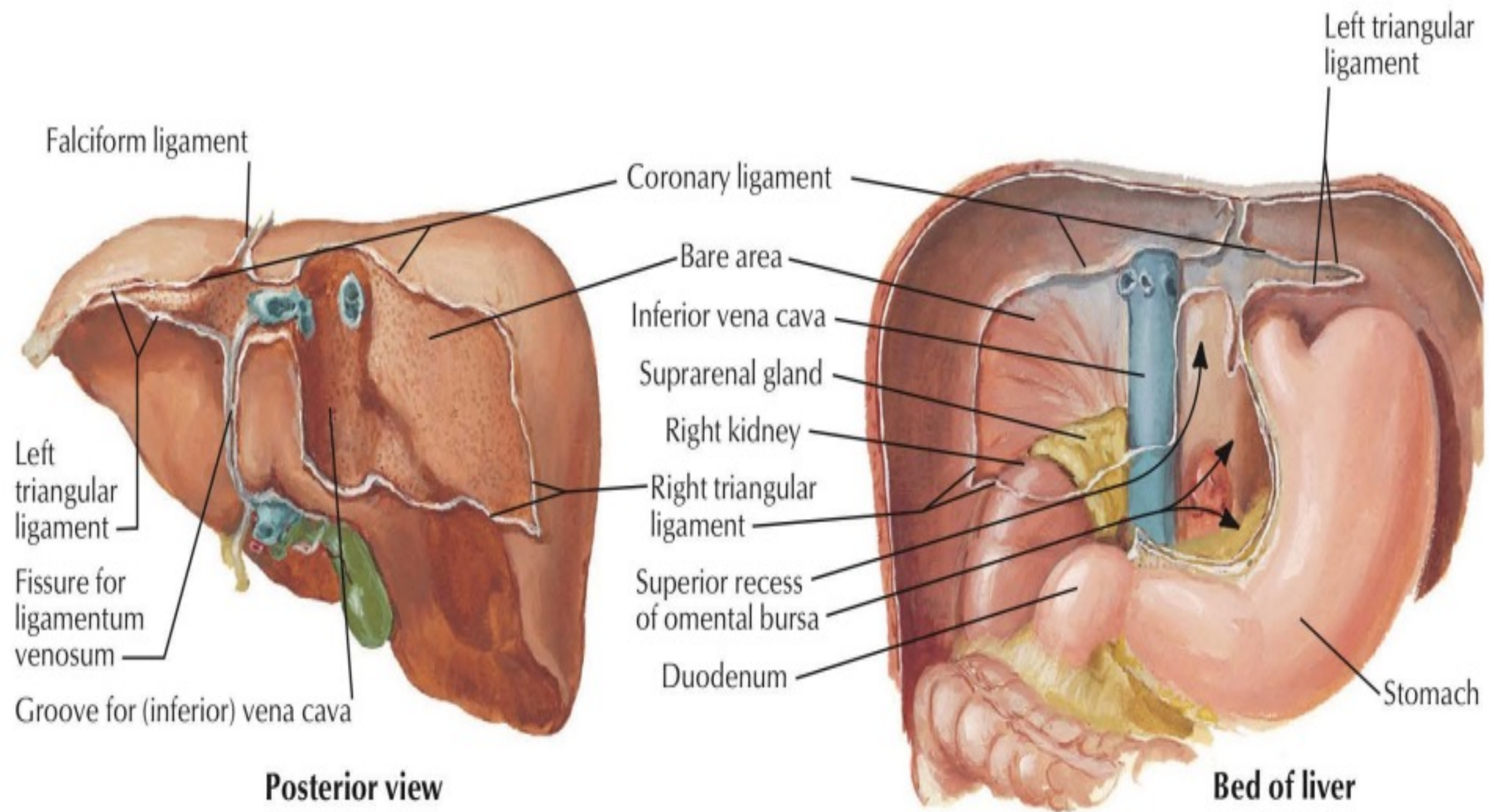


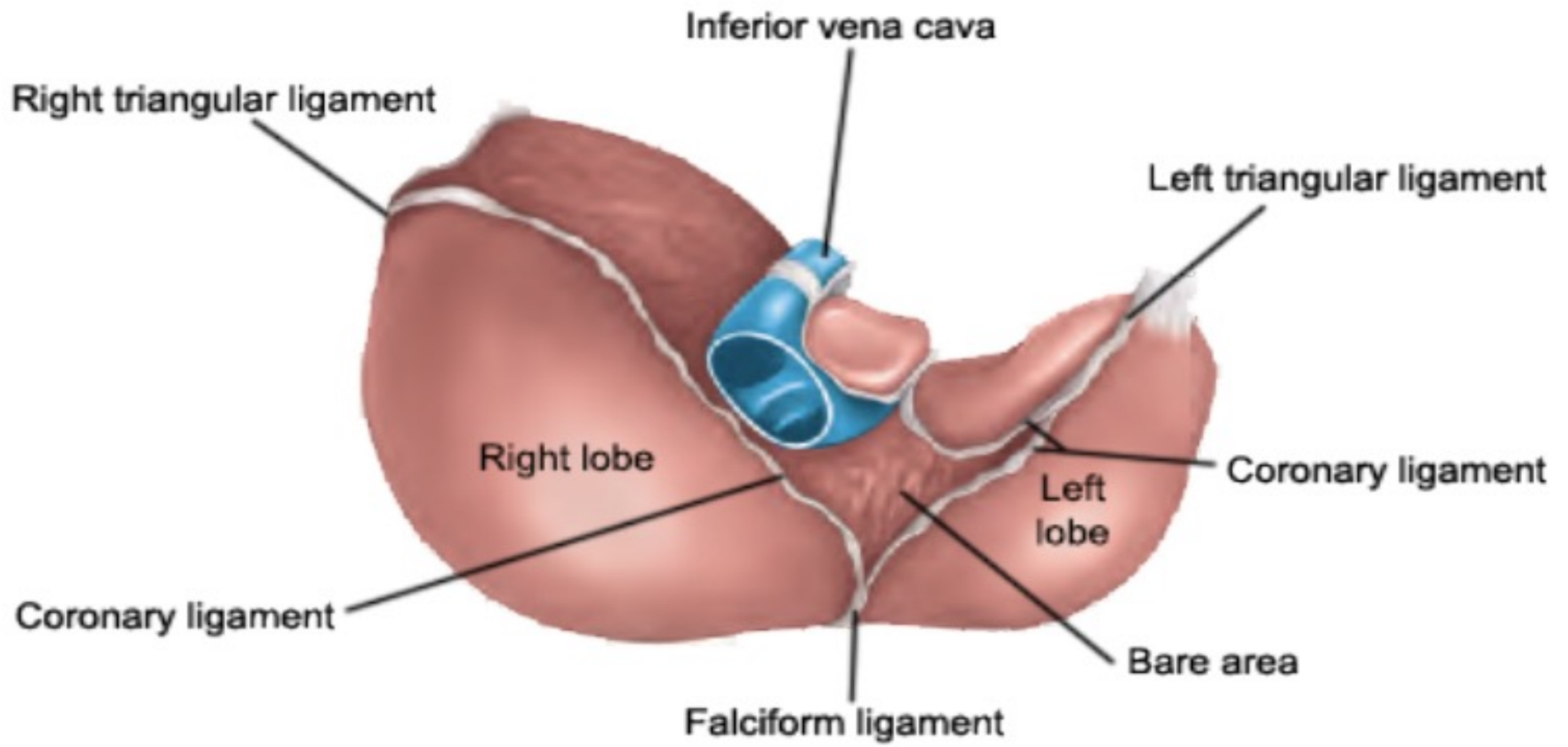






*F. Netter M.D.*





**Superior view**

# Potential Spaces

- **Subphrenic recess**

- Between diaphragm and the anterior and superior aspects of the diaphragmatic surface of the liver

- **Subhepatic space**

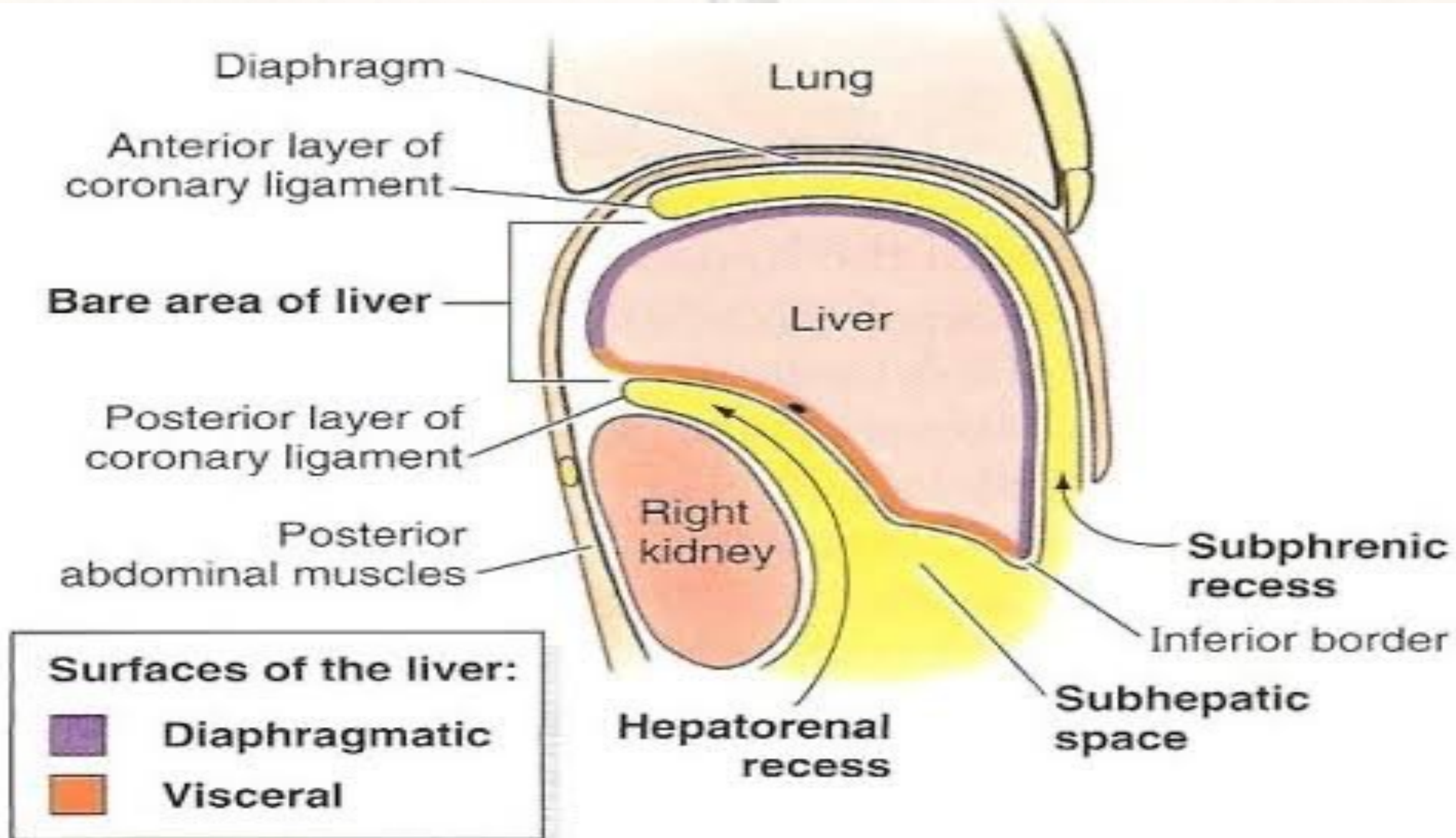
- Peritoneal cavity immediately inferior to the liver

- **Hepatorenal recess (Morrison pouch)**

- Between the right part of the visceral surface of the liver and the right kidney and adrenal gland
- Gravity-dependent space

Hepatic flexure

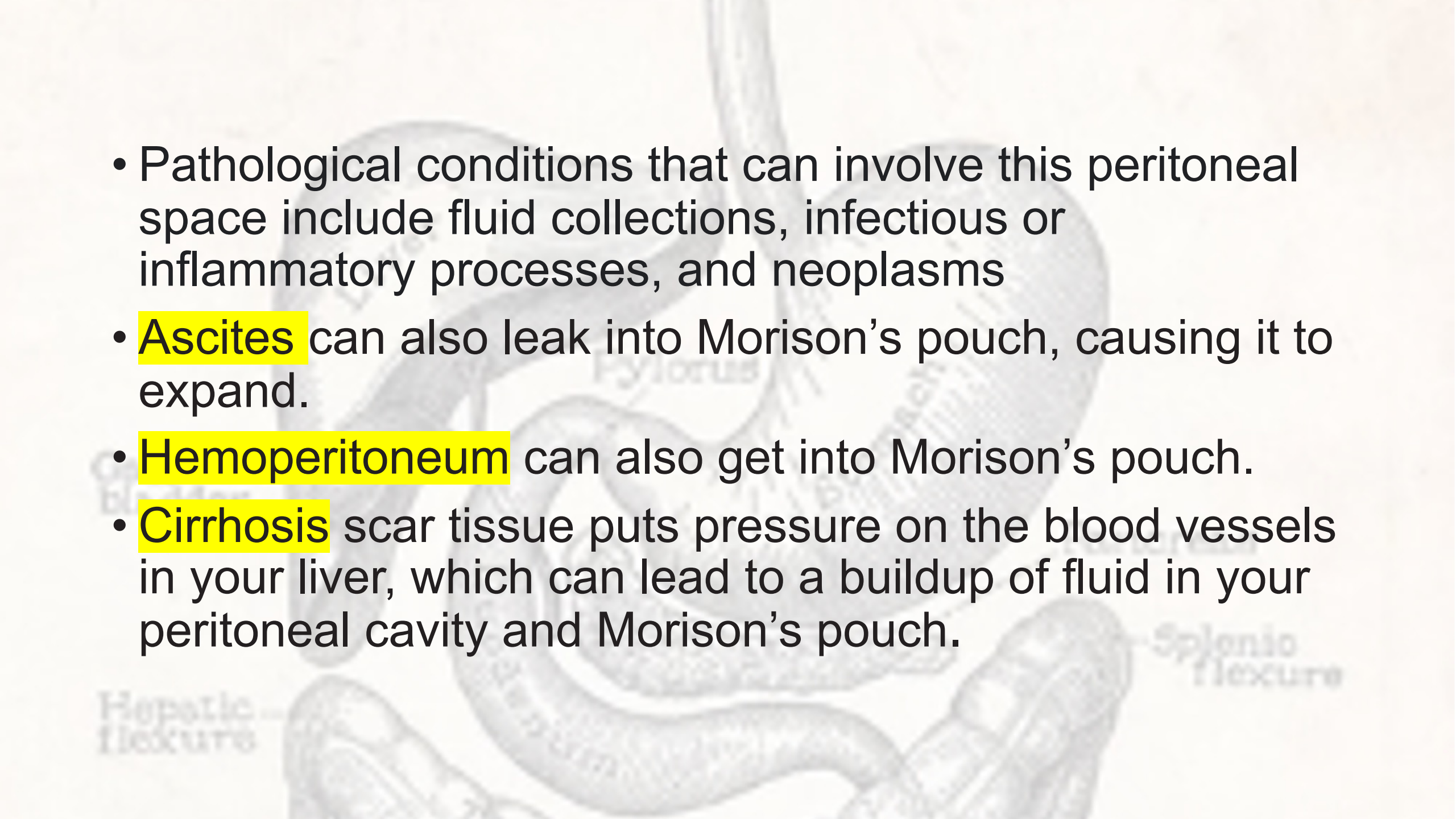
Splenic flexure

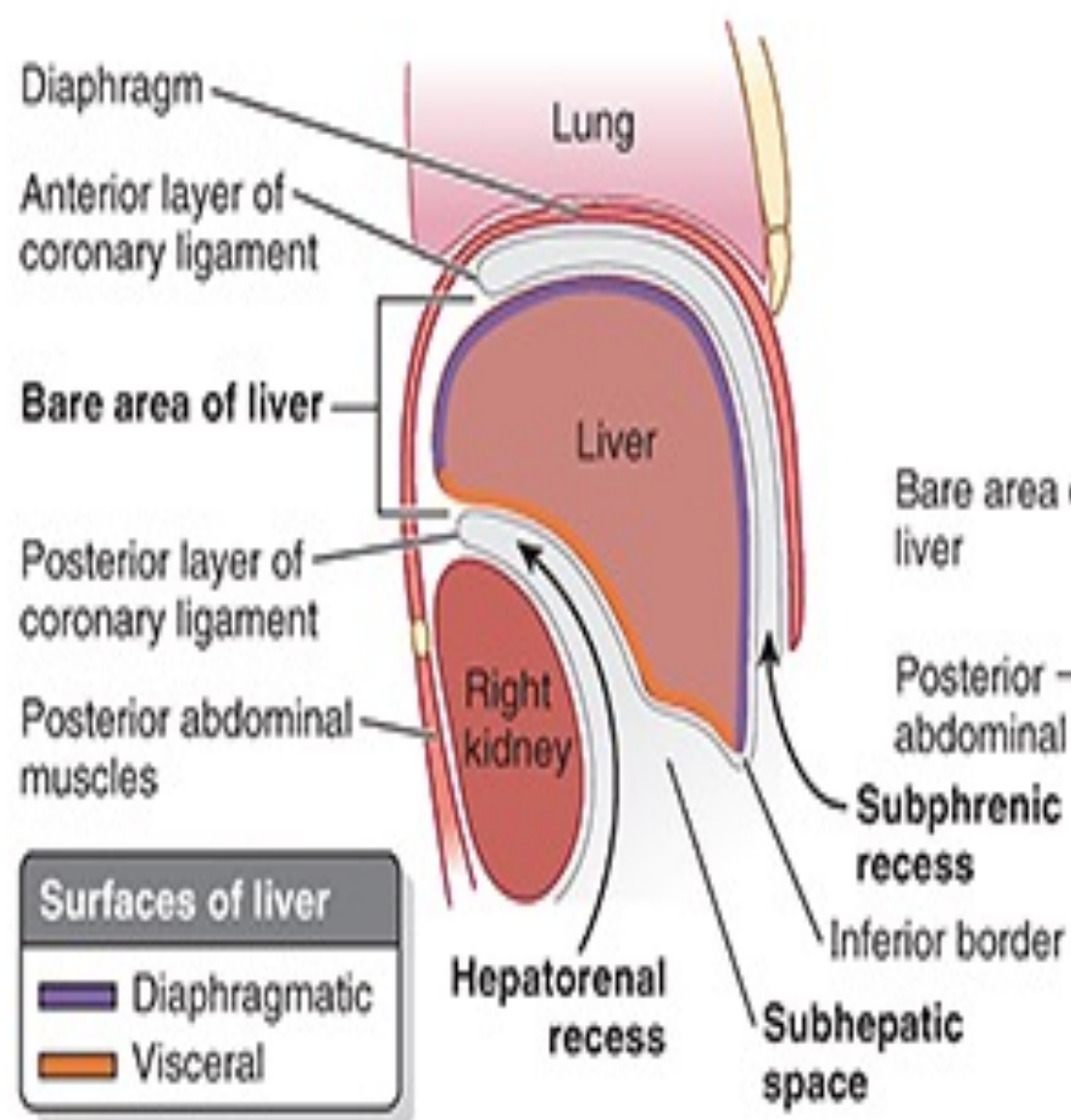


## What is Morison's pouch?

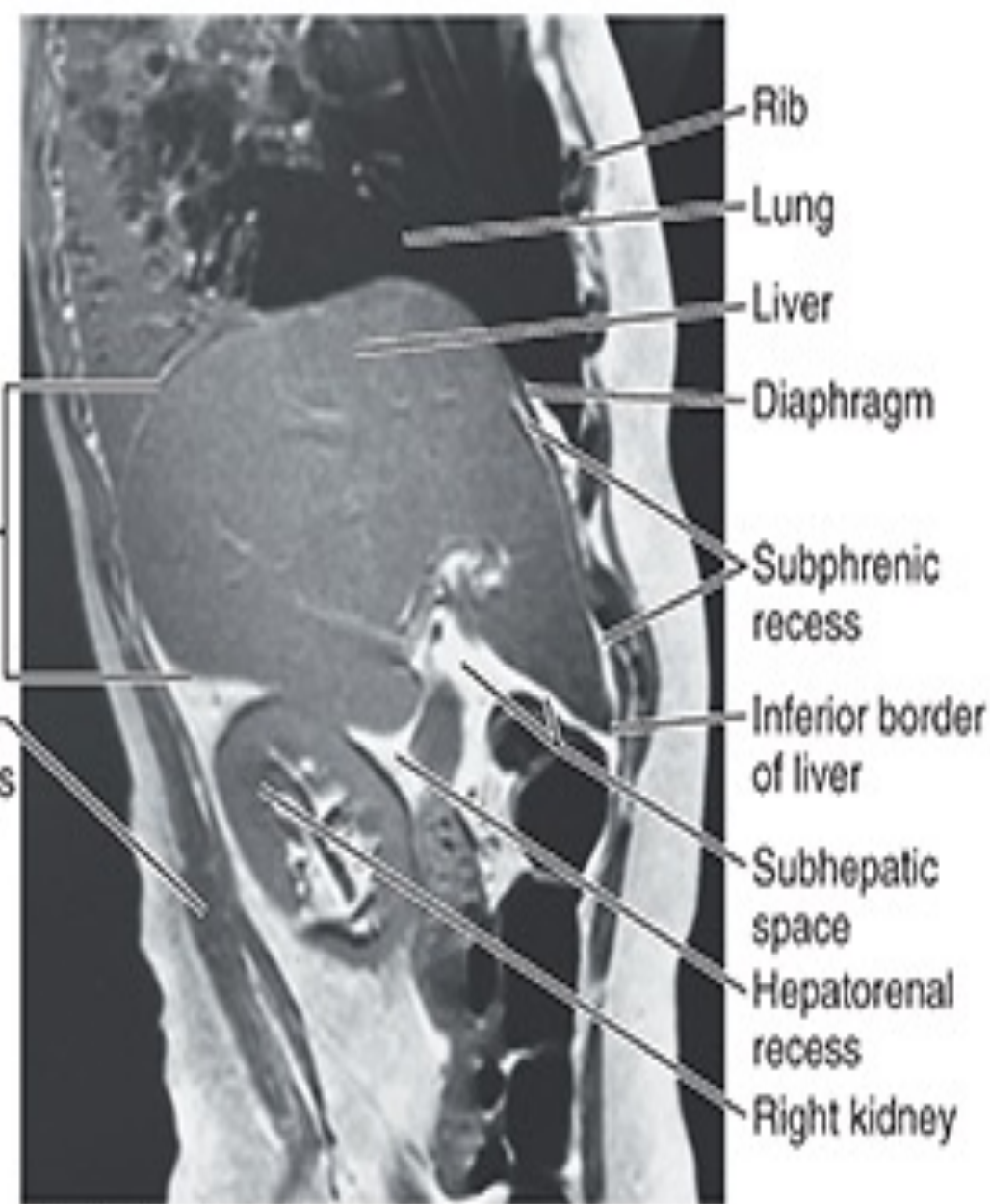
- Morison's pouch is an area between the liver and right kidney.
- It's also called the hepatorenal recess or right subhepatic space.
- Morison's pouch is a potential space that opens up when fluid or blood enters the area.
- When these aren't present, there's no space between your liver and right kidney.
- As a result, doctors use the presence of Morison's pouch on an ultrasound to help diagnose conditions that cause fluid buildup in your abdomen.



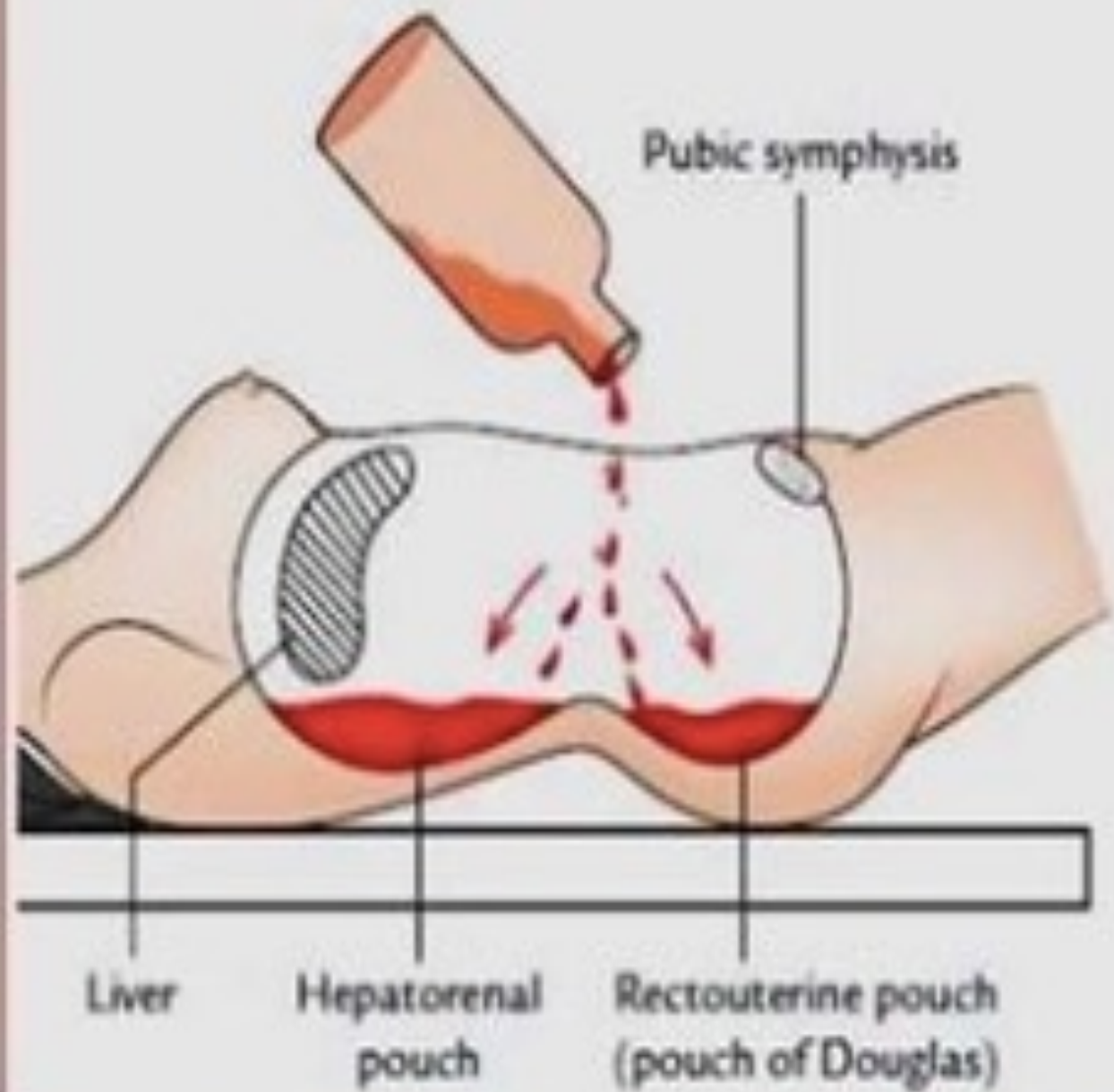
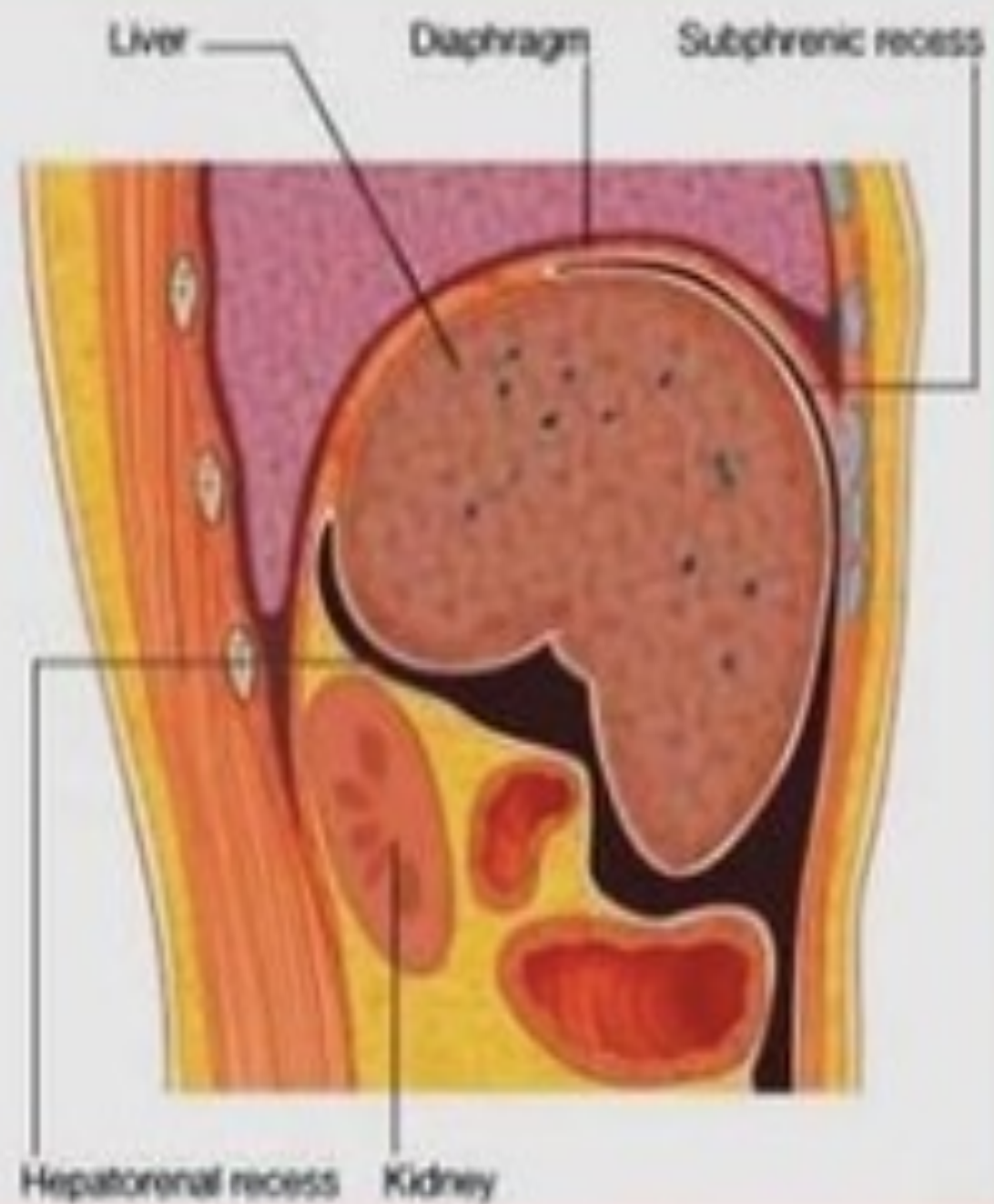
- 
- Pathological conditions that can involve this peritoneal space include fluid collections, infectious or inflammatory processes, and neoplasms
  - **Ascites** can also leak into Morison's pouch, causing it to expand.
  - **Hemoperitoneum** can also get into Morison's pouch.
  - **Cirrhosis** scar tissue puts pressure on the blood vessels in your liver, which can lead to a buildup of fluid in your peritoneal cavity and Morison's pouch.

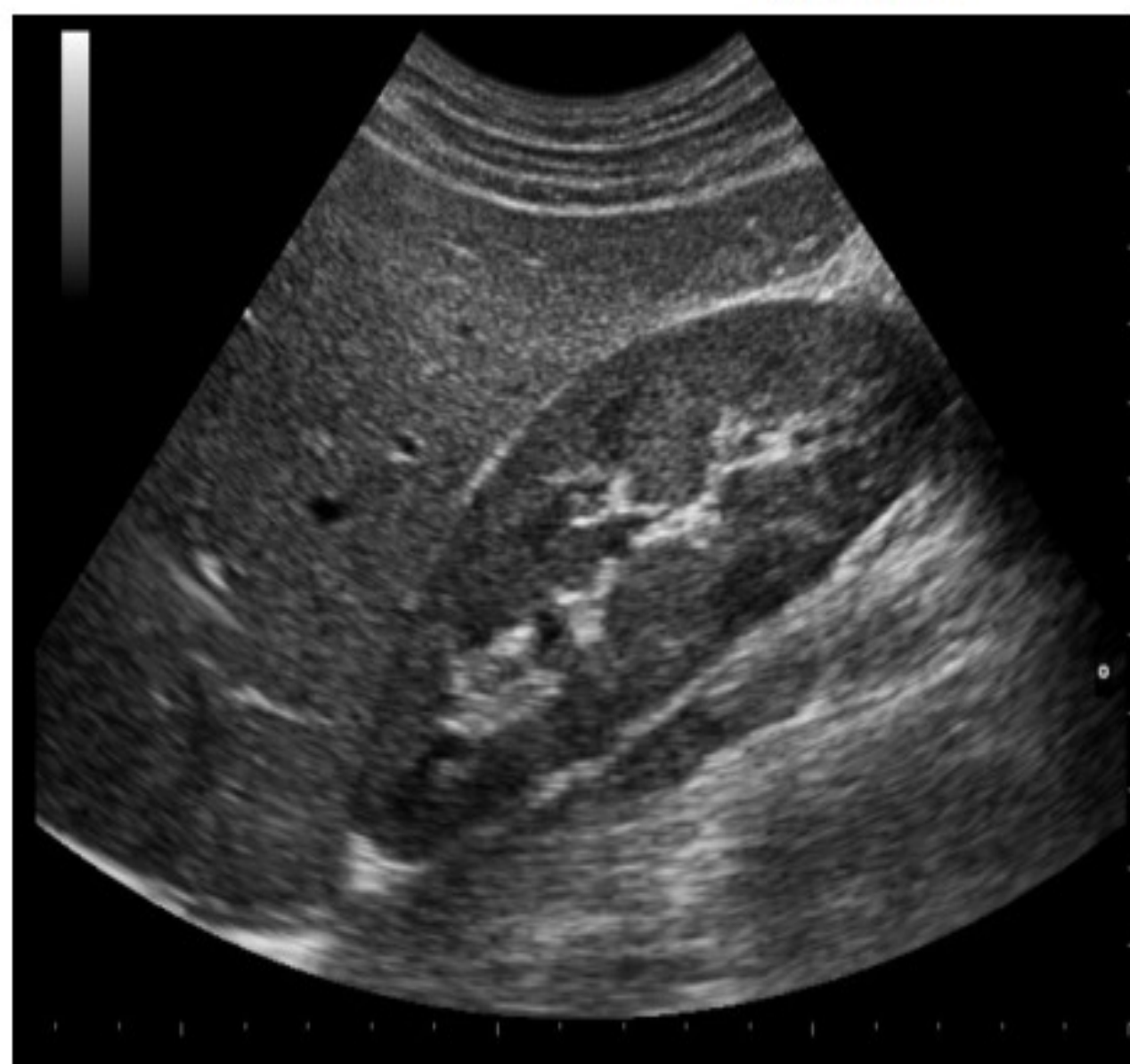


(A) Schematic sagittal section



(B) Sagittal MRI





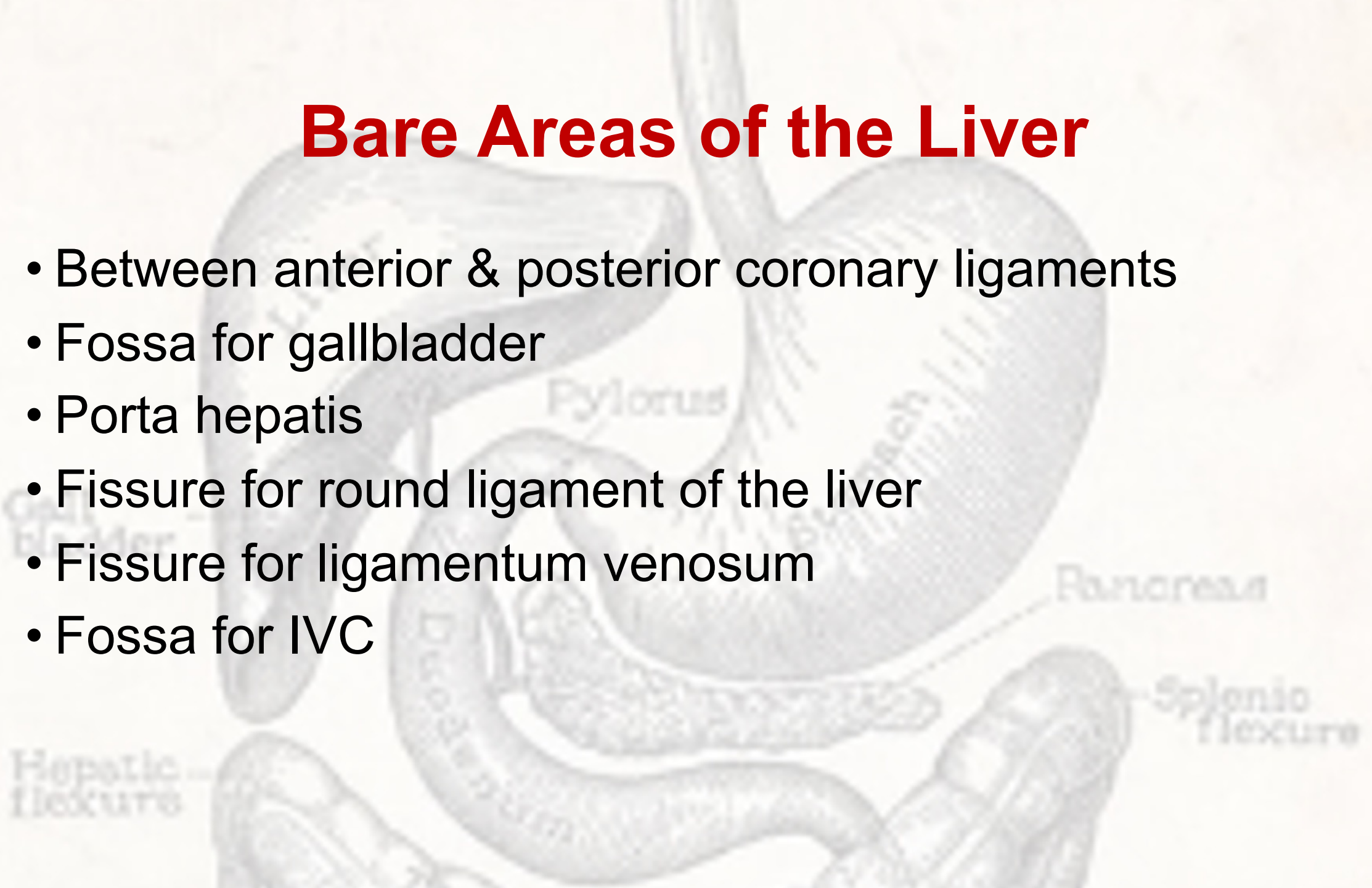
Normal hepatorenal recess

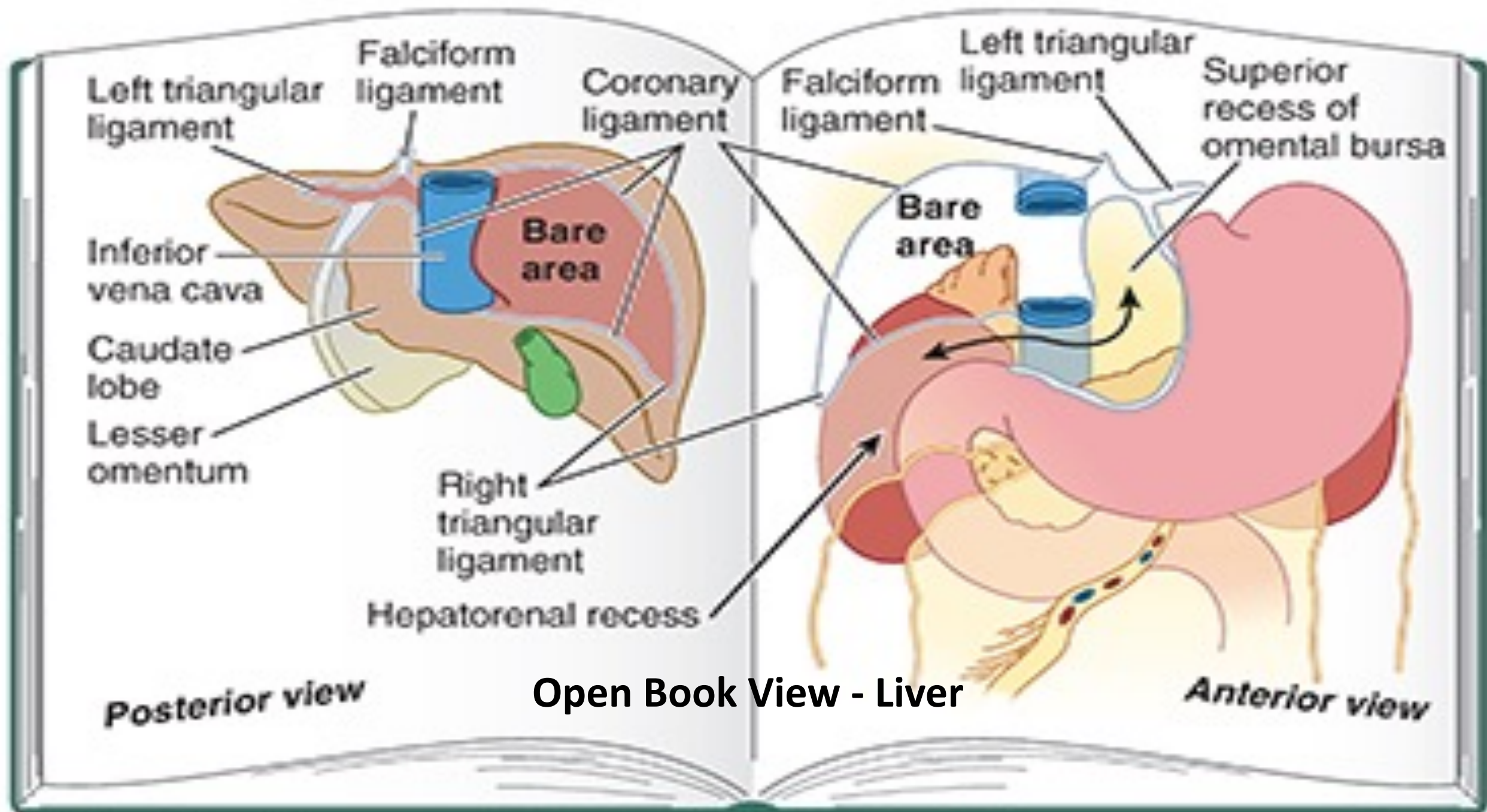


Free fluid in hepatorenal recess

# Bare Areas of the Liver

- Between anterior & posterior coronary ligaments
- Fossa for gallbladder
- Porta hepatis
- Fissure for round ligament of the liver
- Fissure for ligamentum venosum
- Fossa for IVC





Coronary ligament

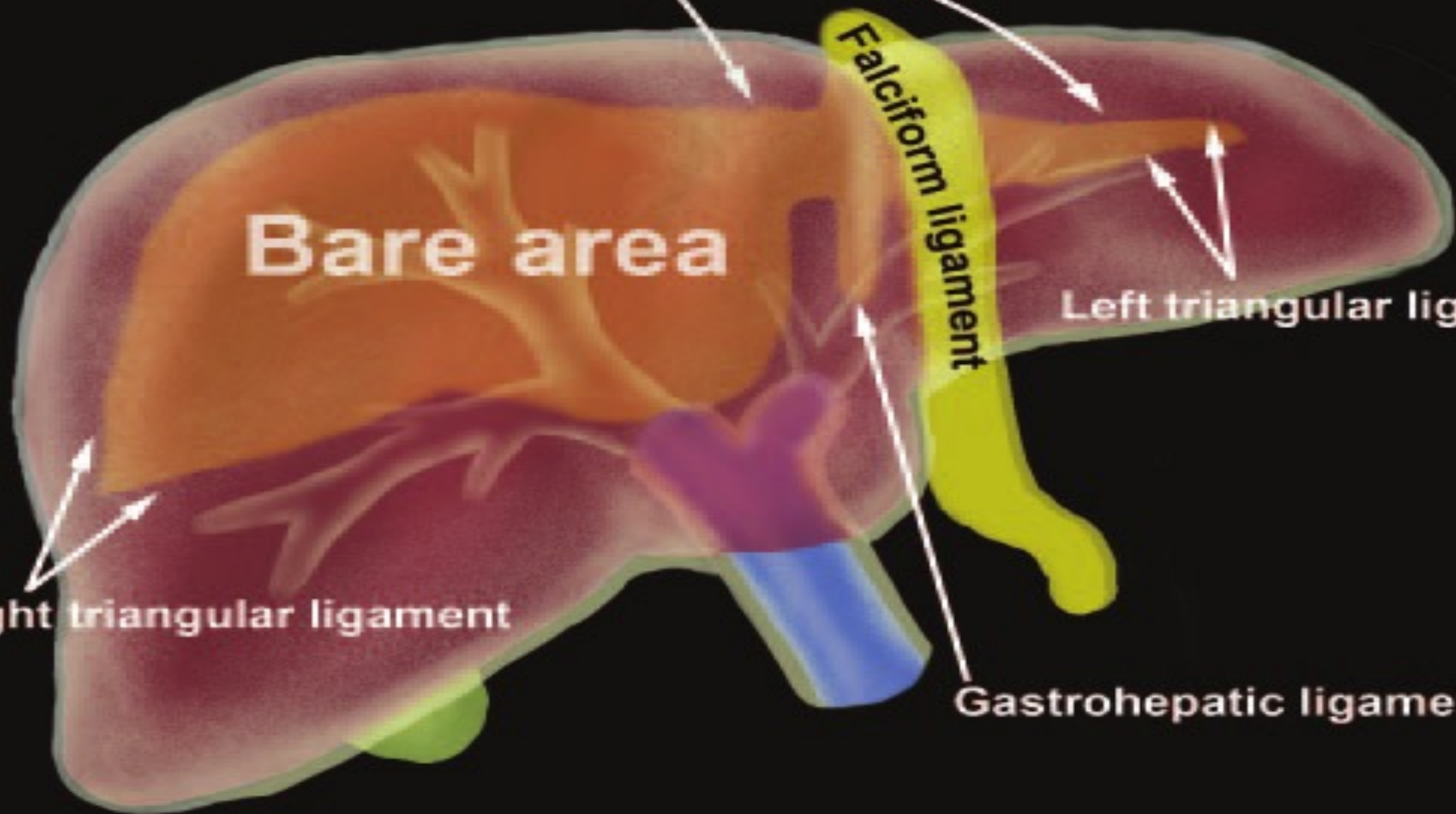
Bare area

Falciform ligament

Left triangular ligament

Right triangular ligament

Gastrohepatic ligament



# Lobes and Segments of the Liver

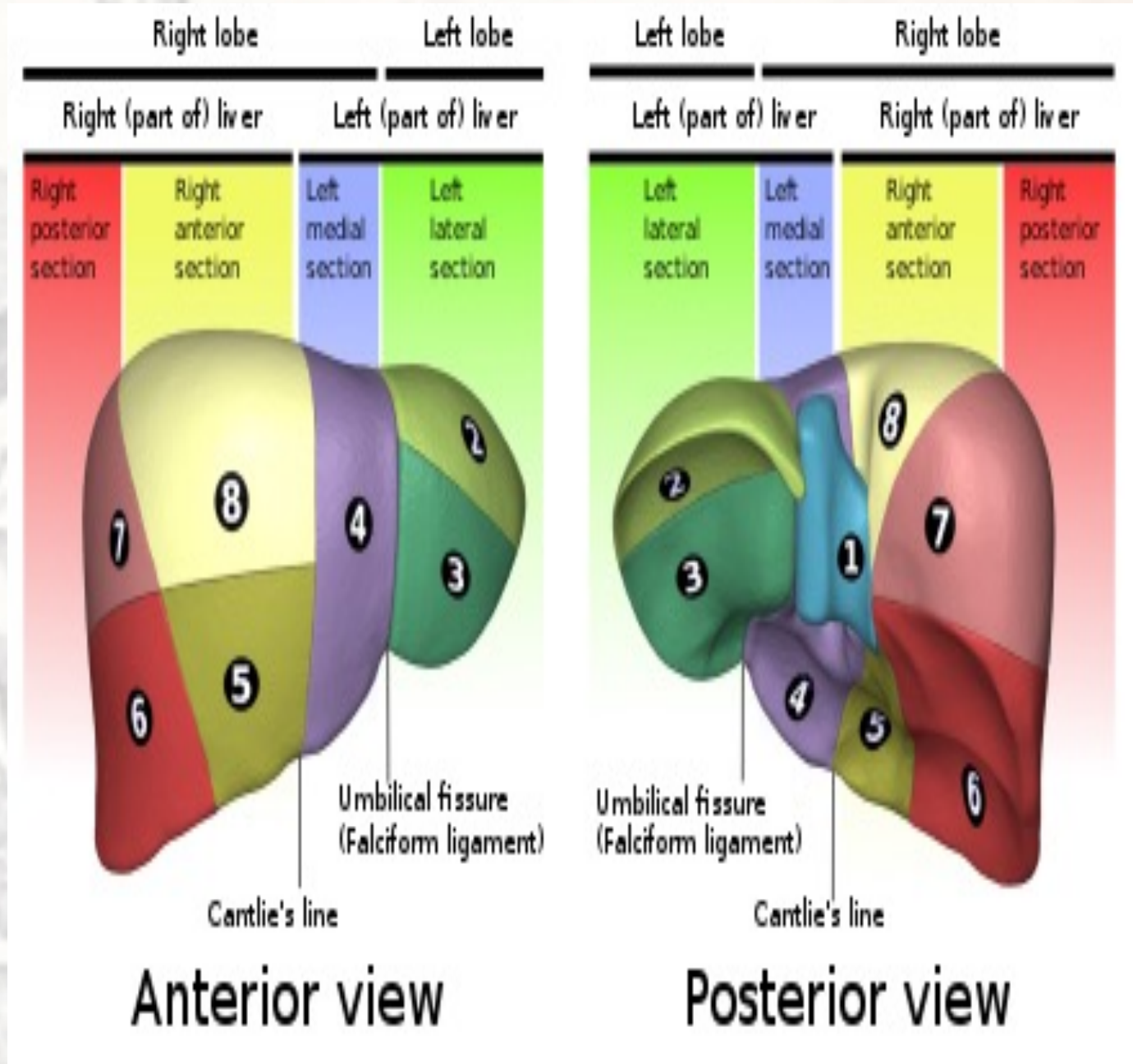
- Anatomically, the liver is viewed as having four main lobes.
- There is a **smaller left lobe** and a **larger right lobe** that are **separated** along the attachment of the **falciform ligament**.
- On the undersurface, there is a **caudate and a quadrate lobe** (which are part of the anatomical right lobe).

Hepatic  
flexure

Splenic  
flexure



- The distribution of the portal blood supply and biliary drainage of the liver allows the organ to be functionally divided into four sectors, which are subsequently divided to give a total of eight segments.



# Functional division of the liver

- The division of the liver into equally sized functional left and right lobes is done by drawing a line through the midline of the gallbladder and the inferior vena cava .
- As opposed to the anatomical division that results in the caudate and quadrate lobes being between the right and left anatomical lobes of the liver, this division results in the caudate and quadrate lobes being a part of the functional left lobe.

Hepatic  
flexure

Spleno  
flexure

# Functional left lobe

- The functional left lobe is divided into a **left lateral** and a **left medial** sector along the attachment of the **falciform ligament** and through the fissures for ligamentum venosum and ligamentum teres.
- The left lateral lobe lies to the left of the fissures and falciform ligament, while the left medial lobe lies between this line and the main demarcation that separates the liver into its functional lobes.

Hepatic  
flexure

Splenic  
flexure

# Functional right lobe

- Divided into the **right medial** and **right lateral** sectors by an oblique line that passes anteroposteriorly from the midpoint of the right lobe to the vena caval groove.
- There is no visible impression on the liver that illustrates the division of the functional right lobe.
- Because of the rounded shape of the lateral border of the liver, the right medial and right lateral sectors are sometimes referred to as the right anterior and right posterior sectors, respectively.

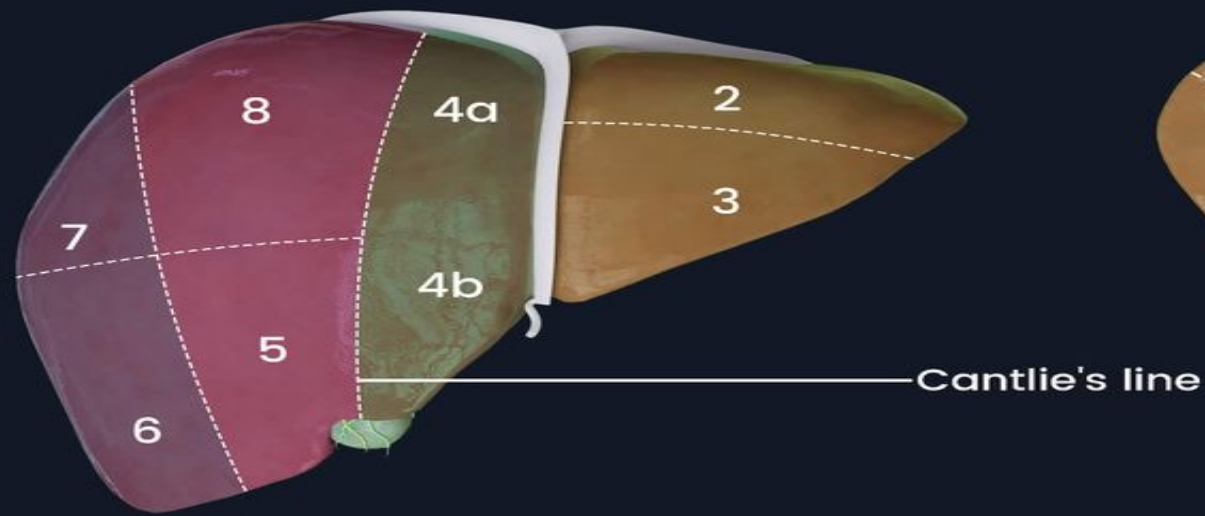
Hepatic  
flexure

Splenic  
flexure

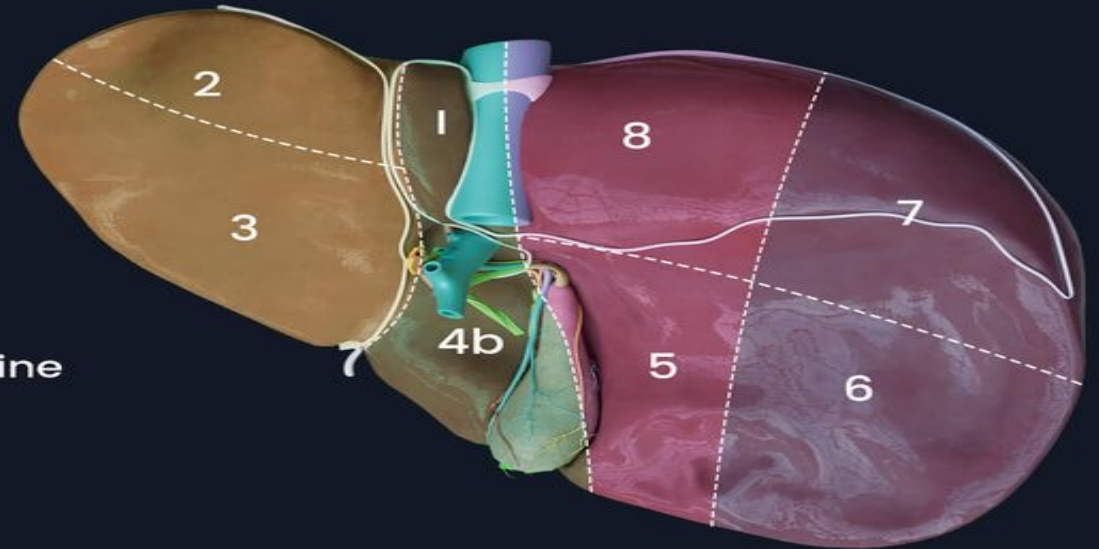
# Hepatic segments

## Liver segments

- Right posterior (lateral) sector
- Right anterior (medial) sector
- Left medial sector
- Left lateral sector

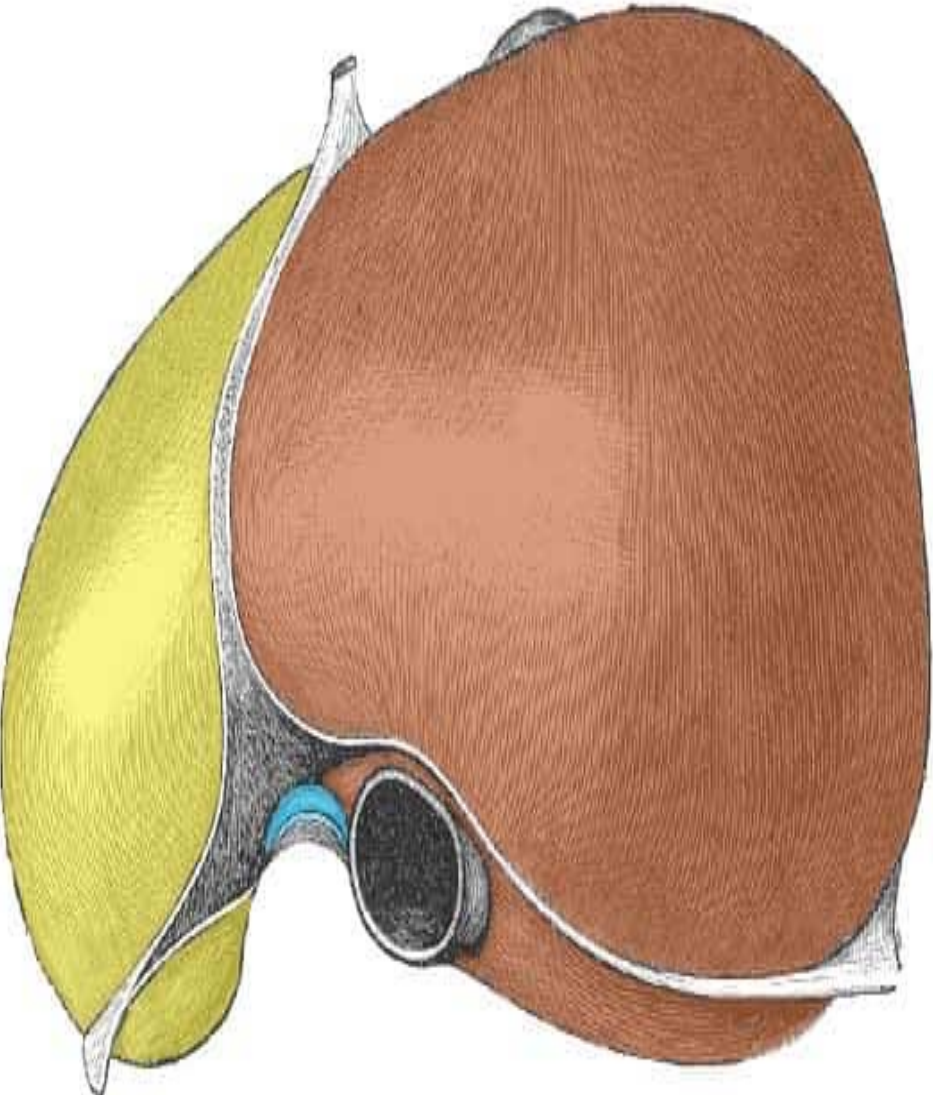


Anterior view

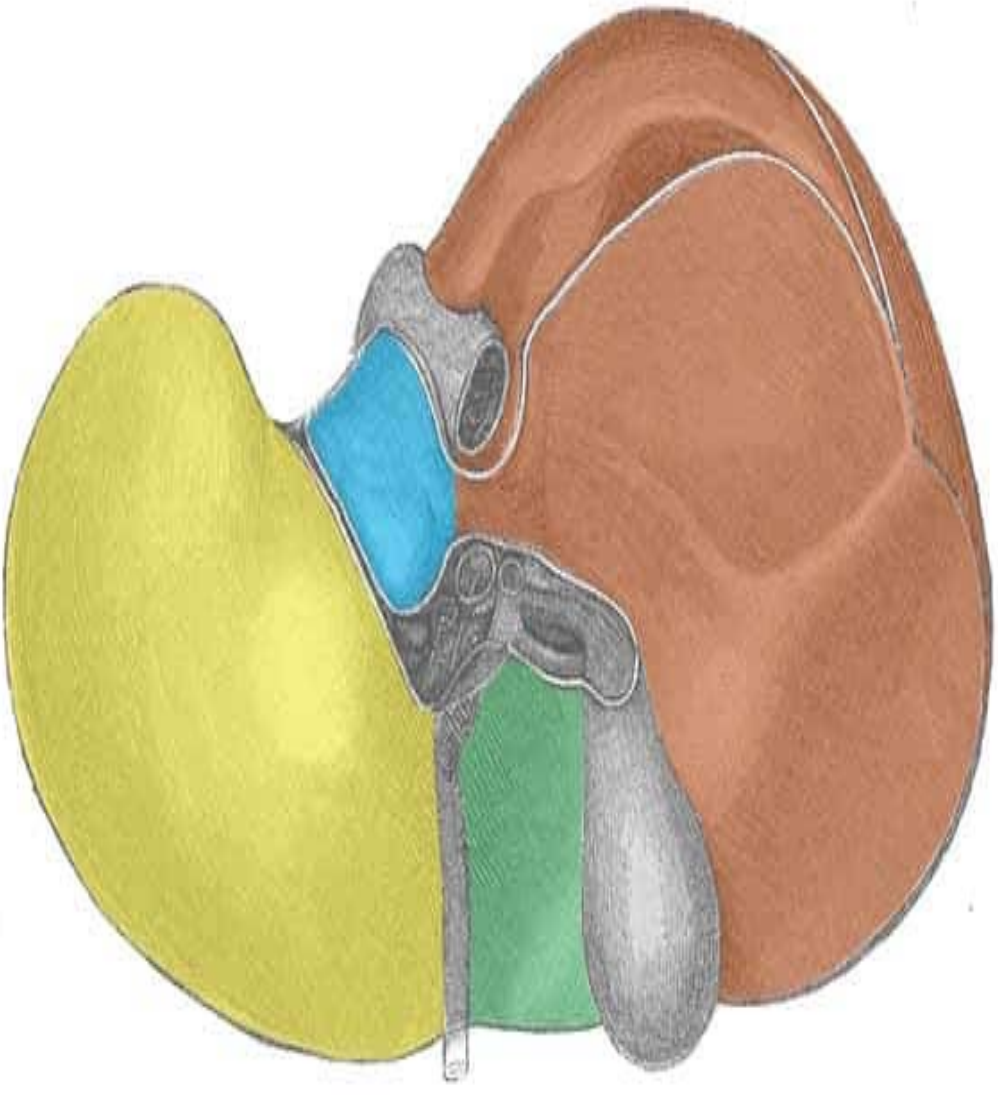






Inferior view

# Superior Surface

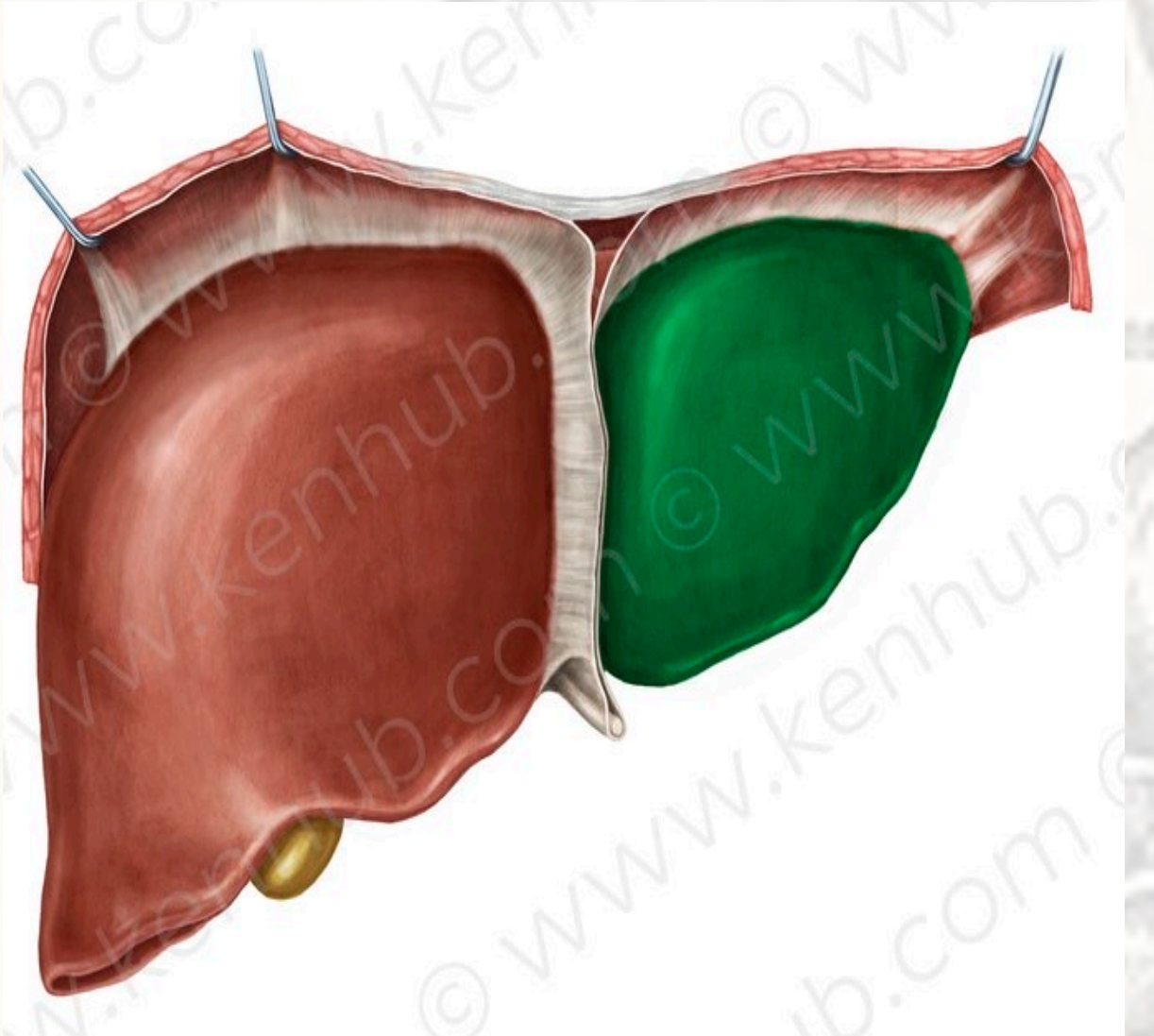


# Inferior Surface

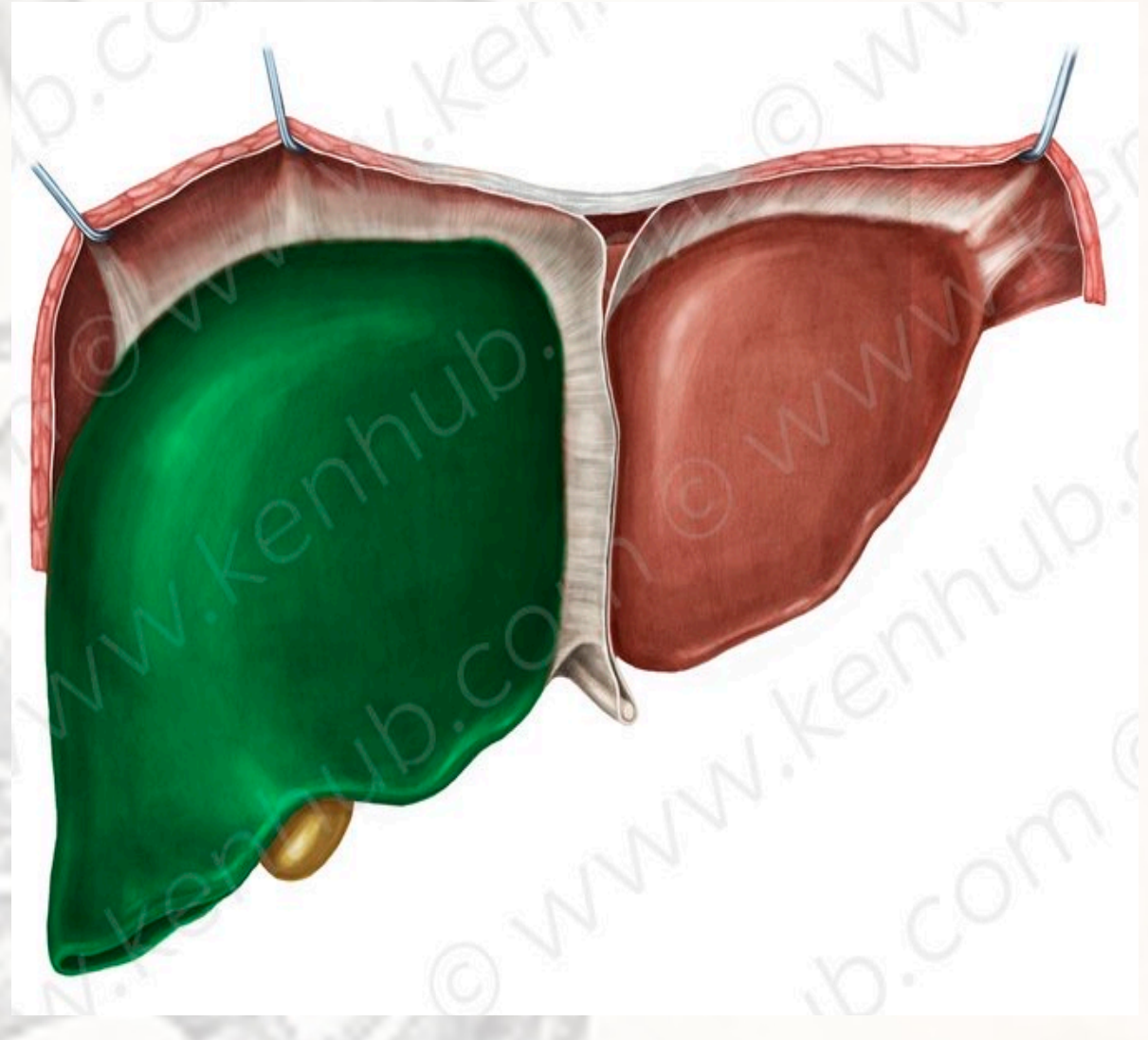


-  Left
-  Right
-  Caudate
-  Quadrate

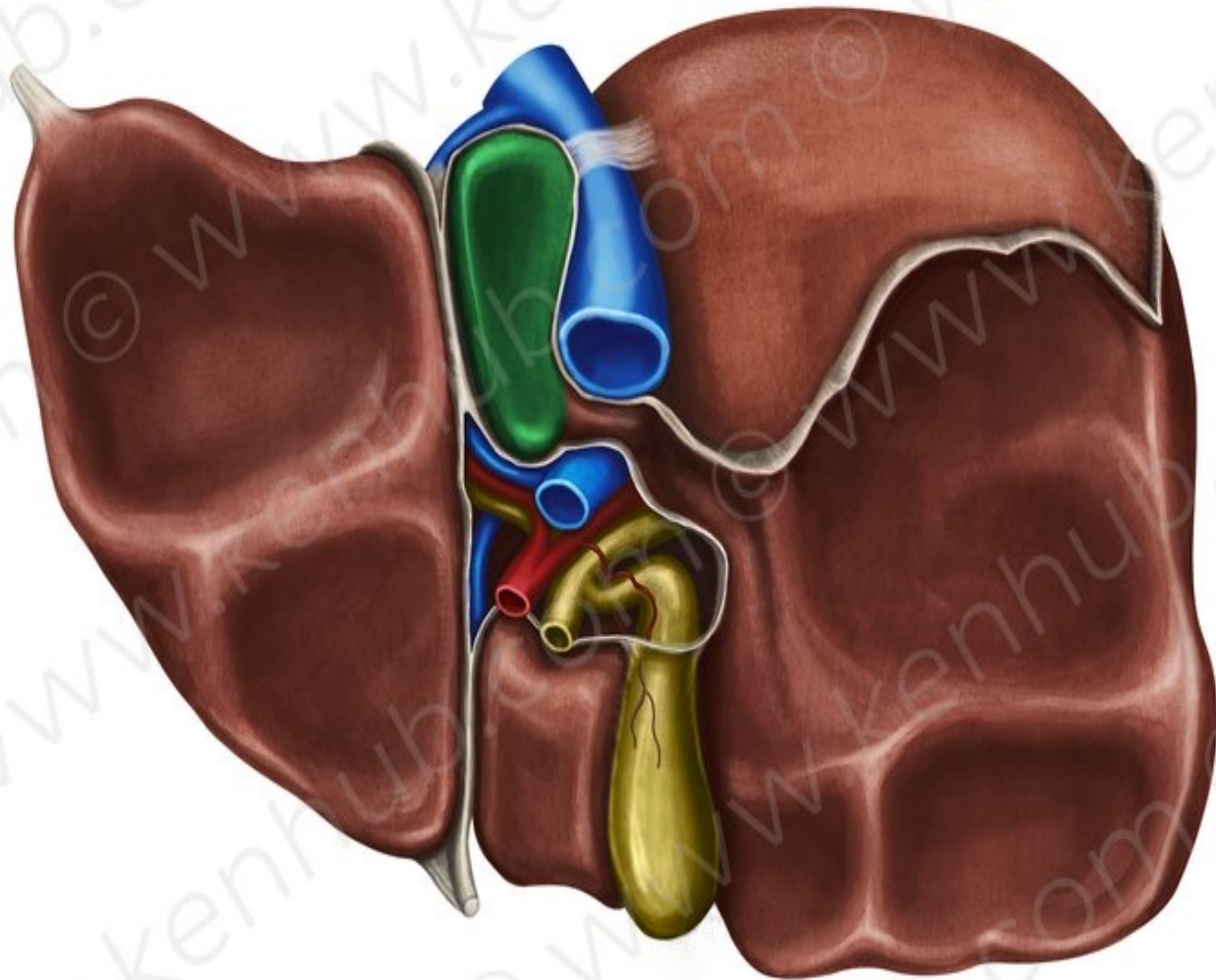
**Left Lobe**



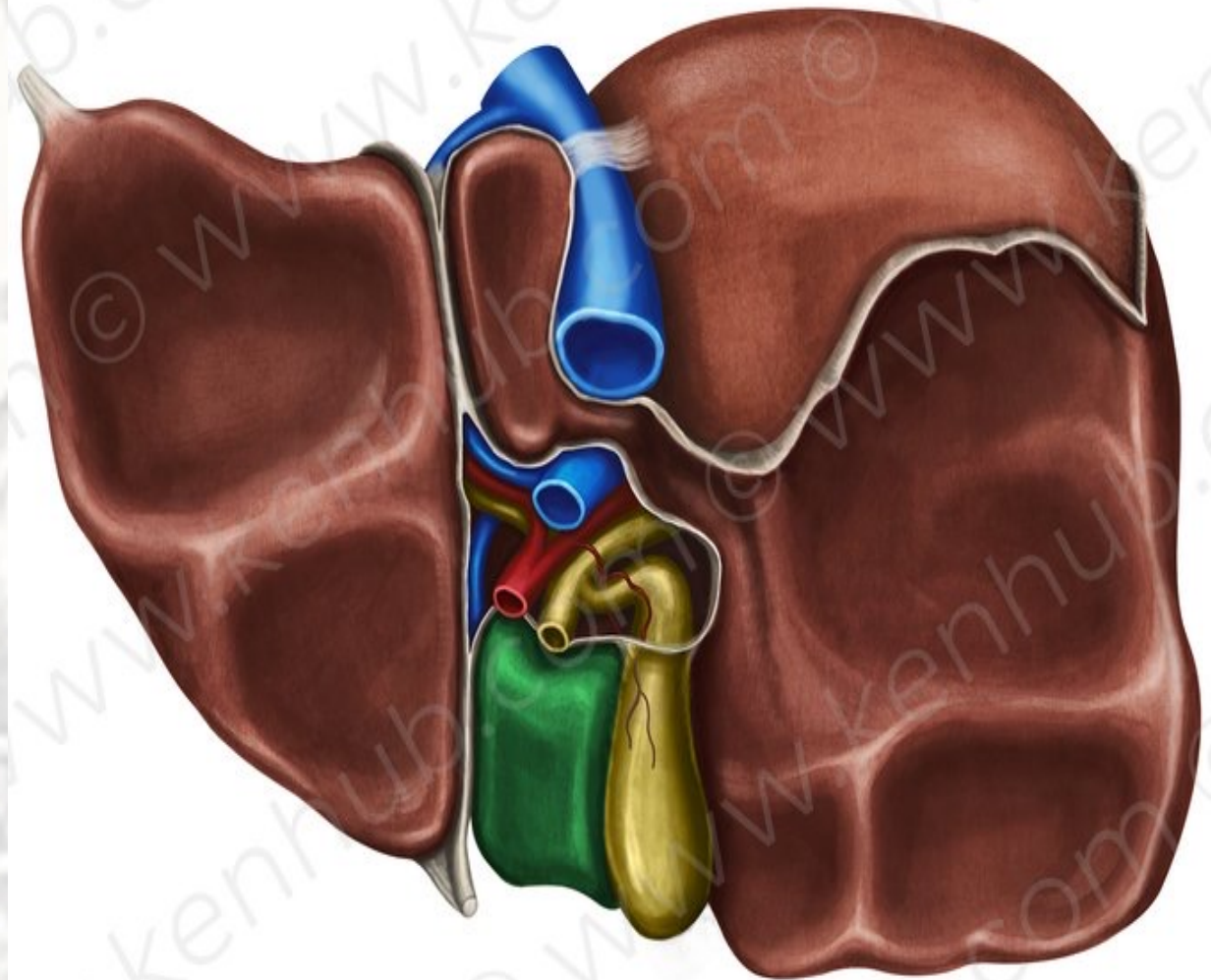
**Right Lobe**



## Caudate Lobe

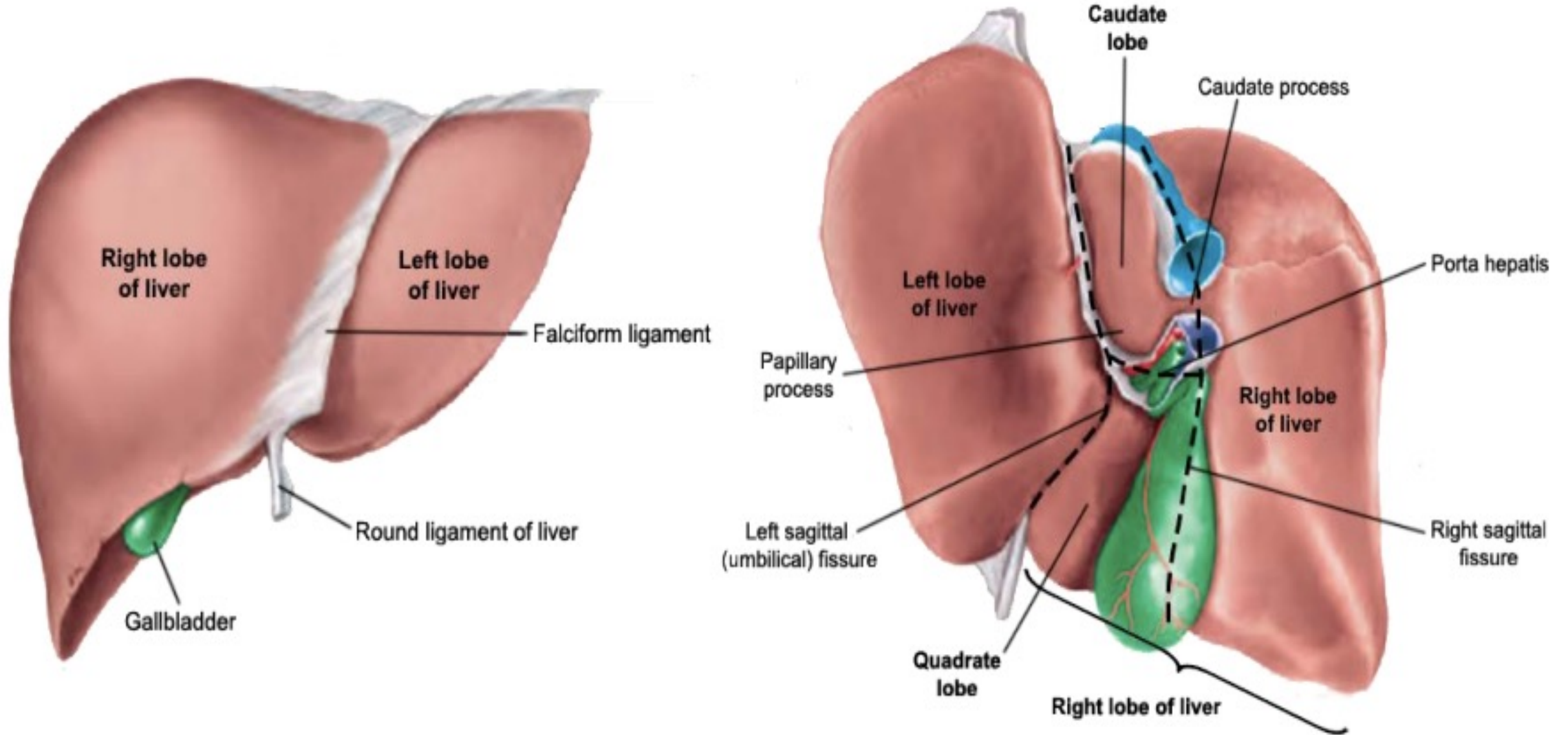


## Quadrate Lobe

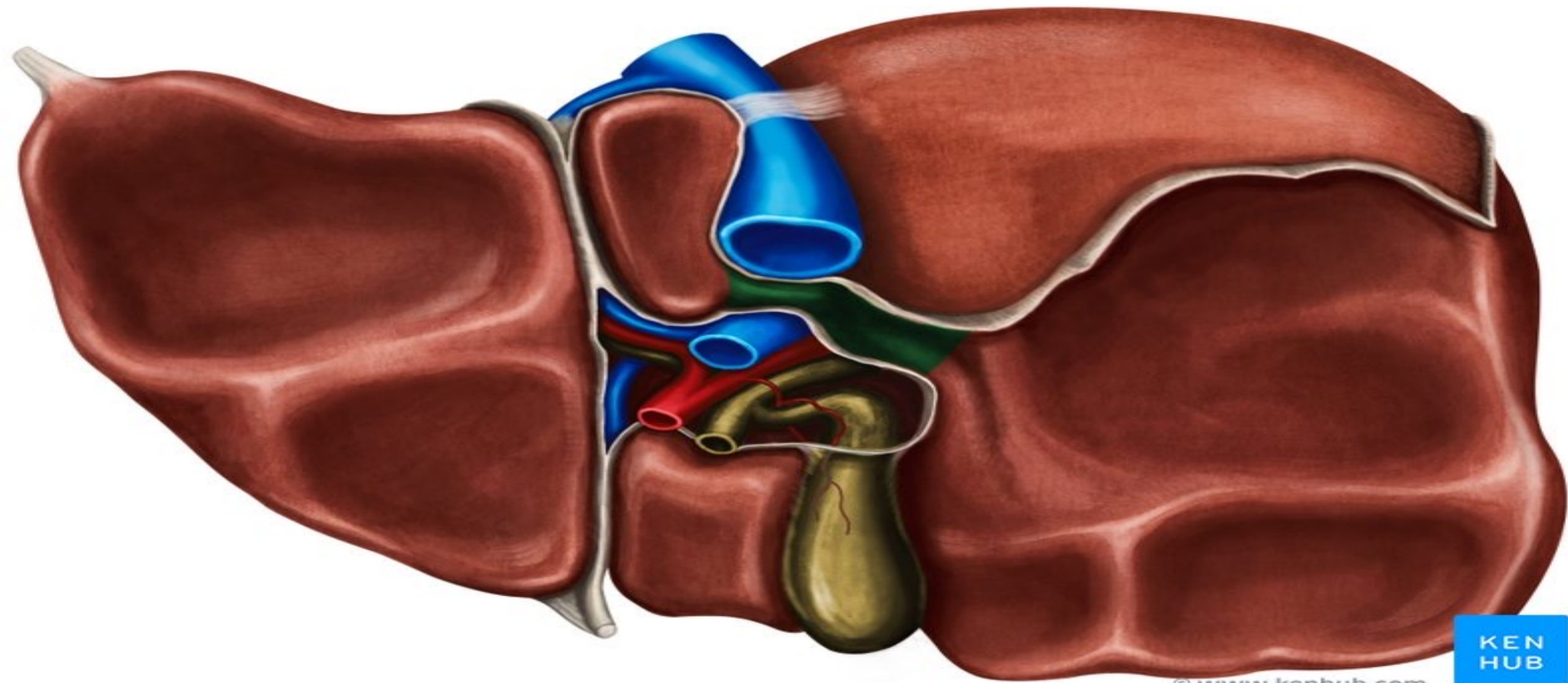




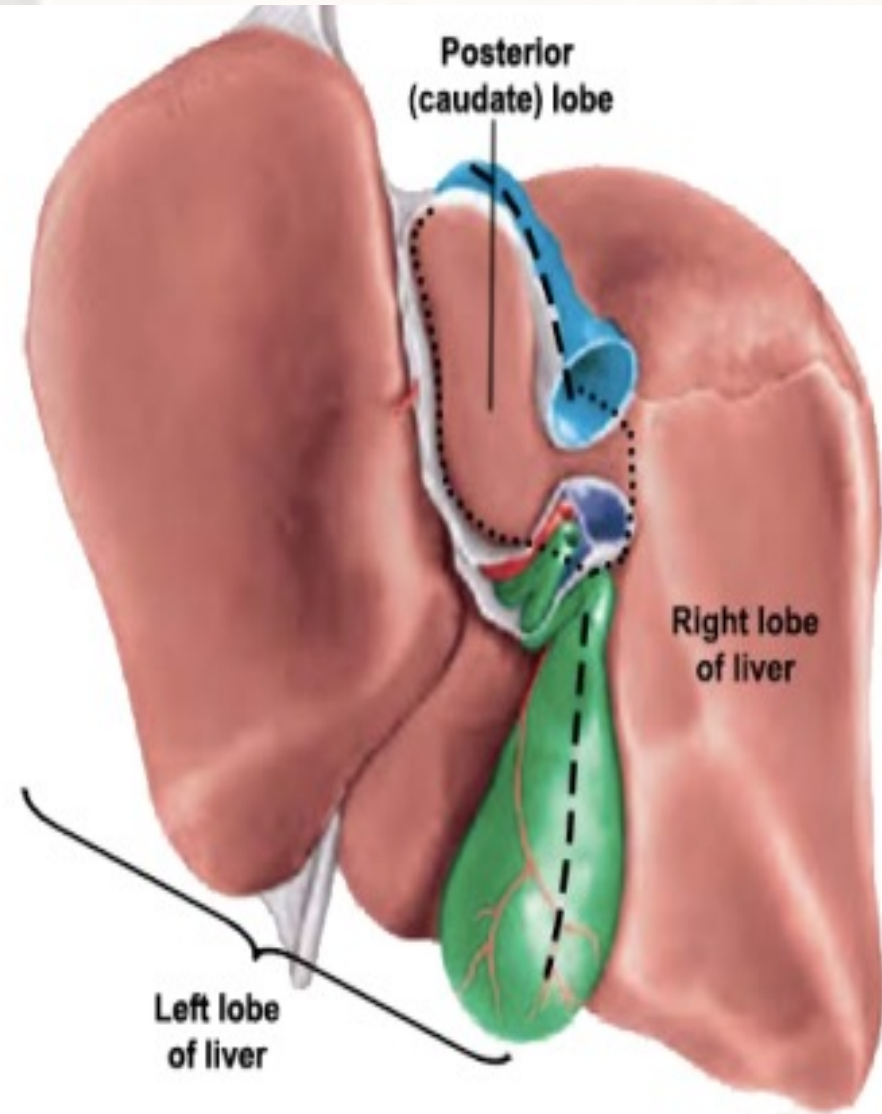
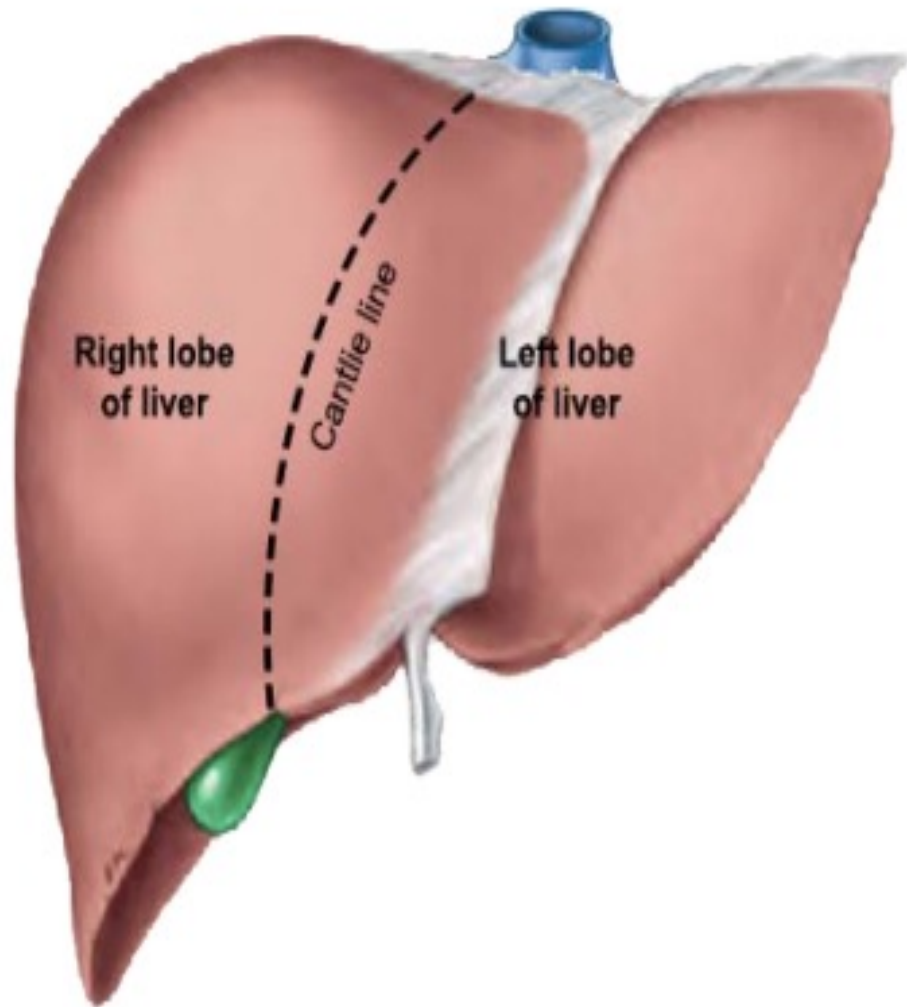
# Lobes of the Liver

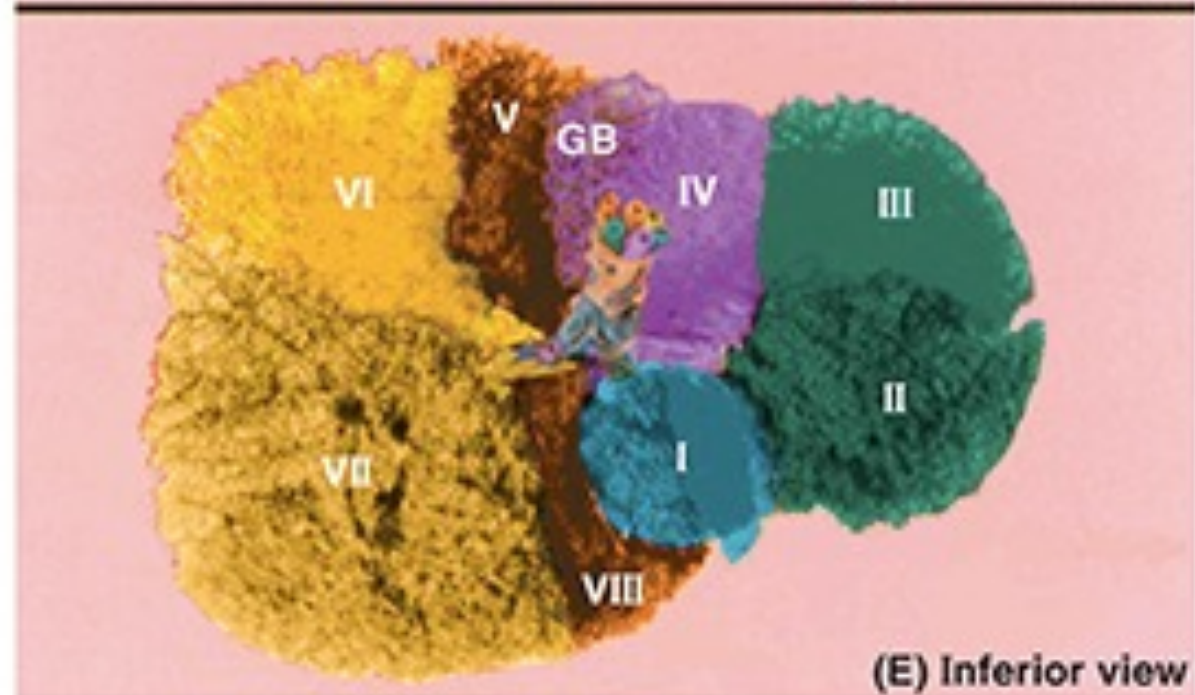
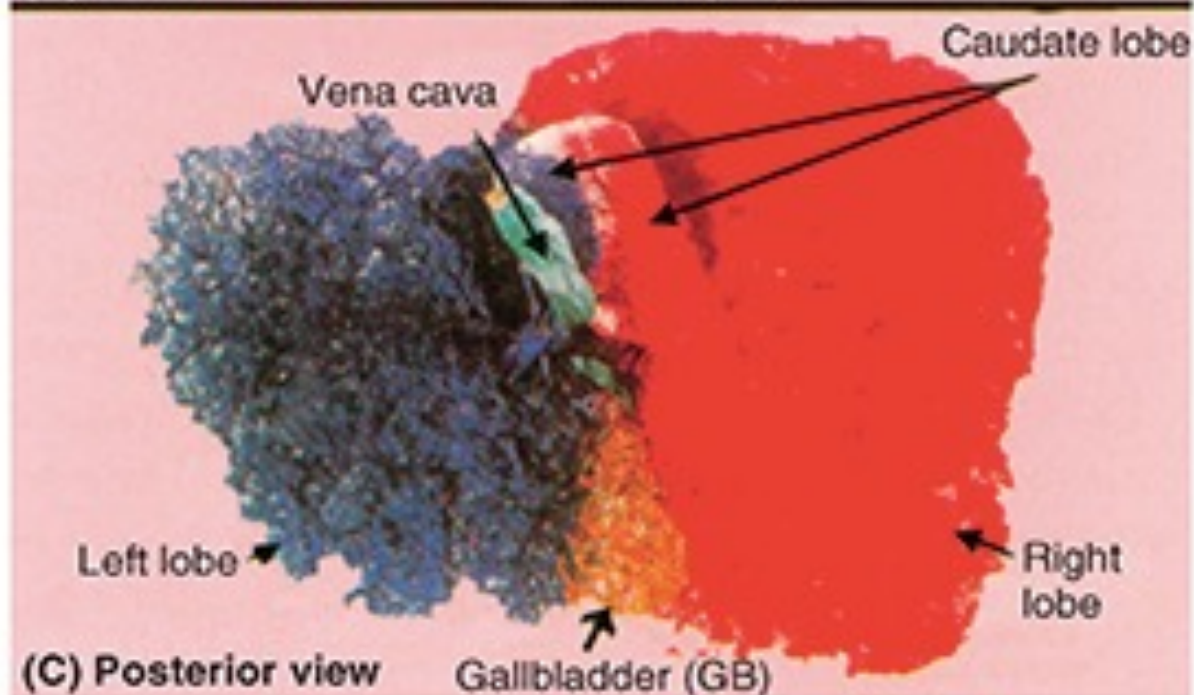
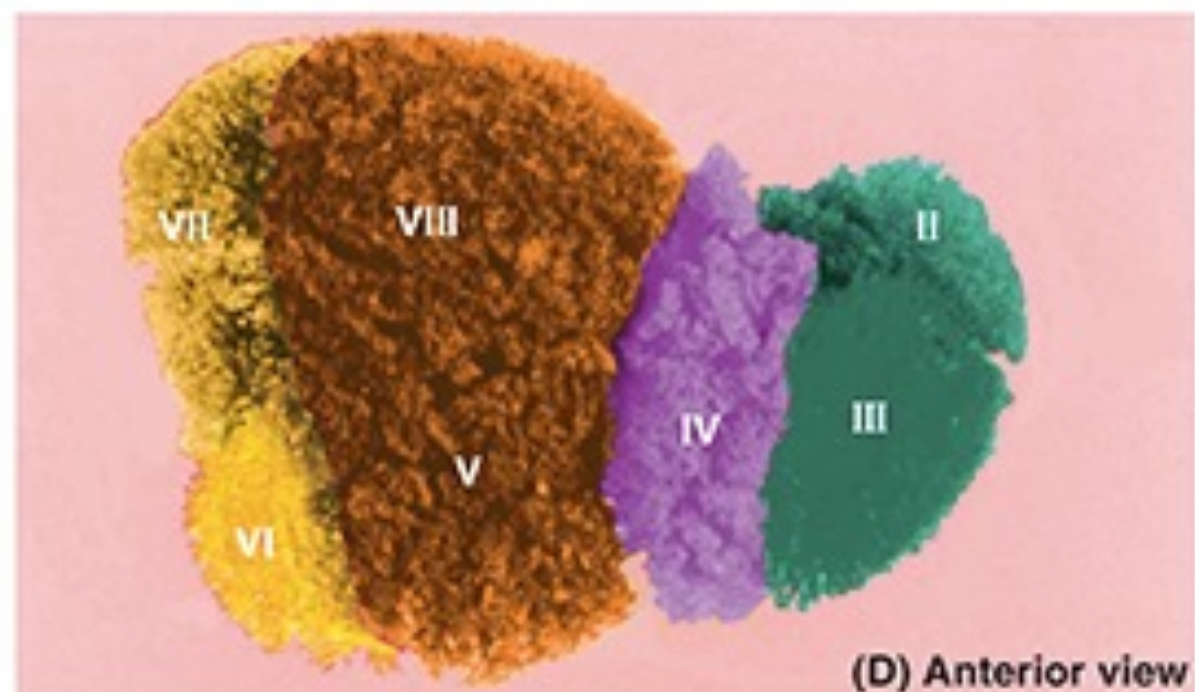
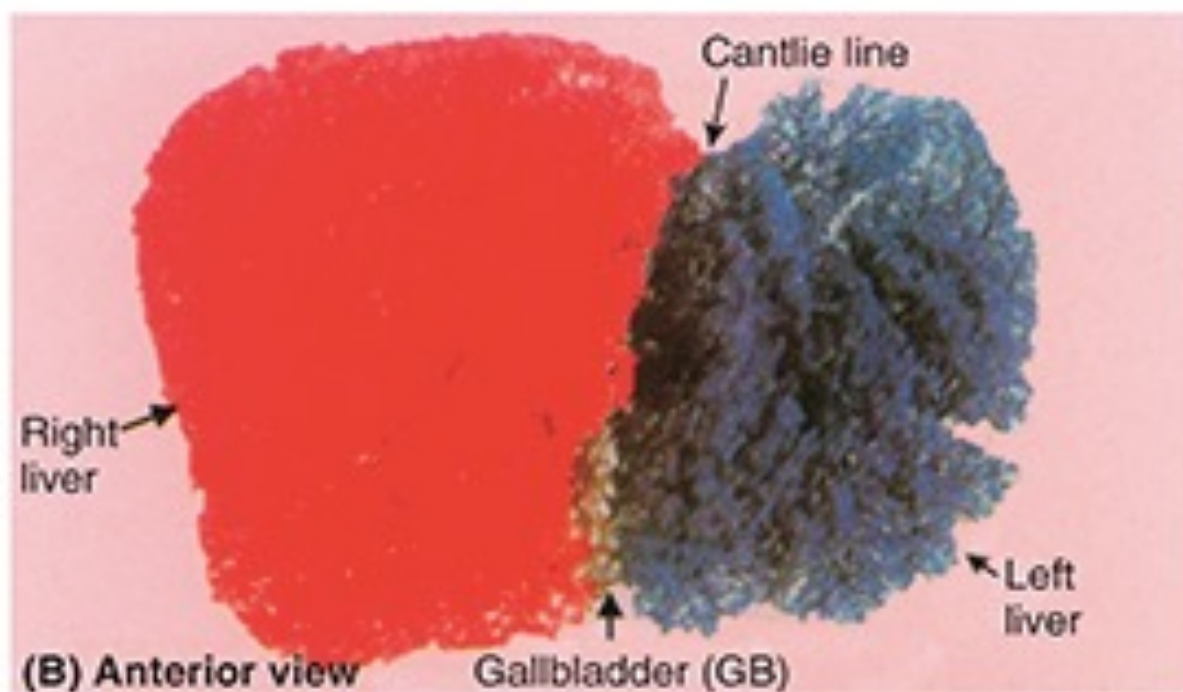


# Lobes of the Liver

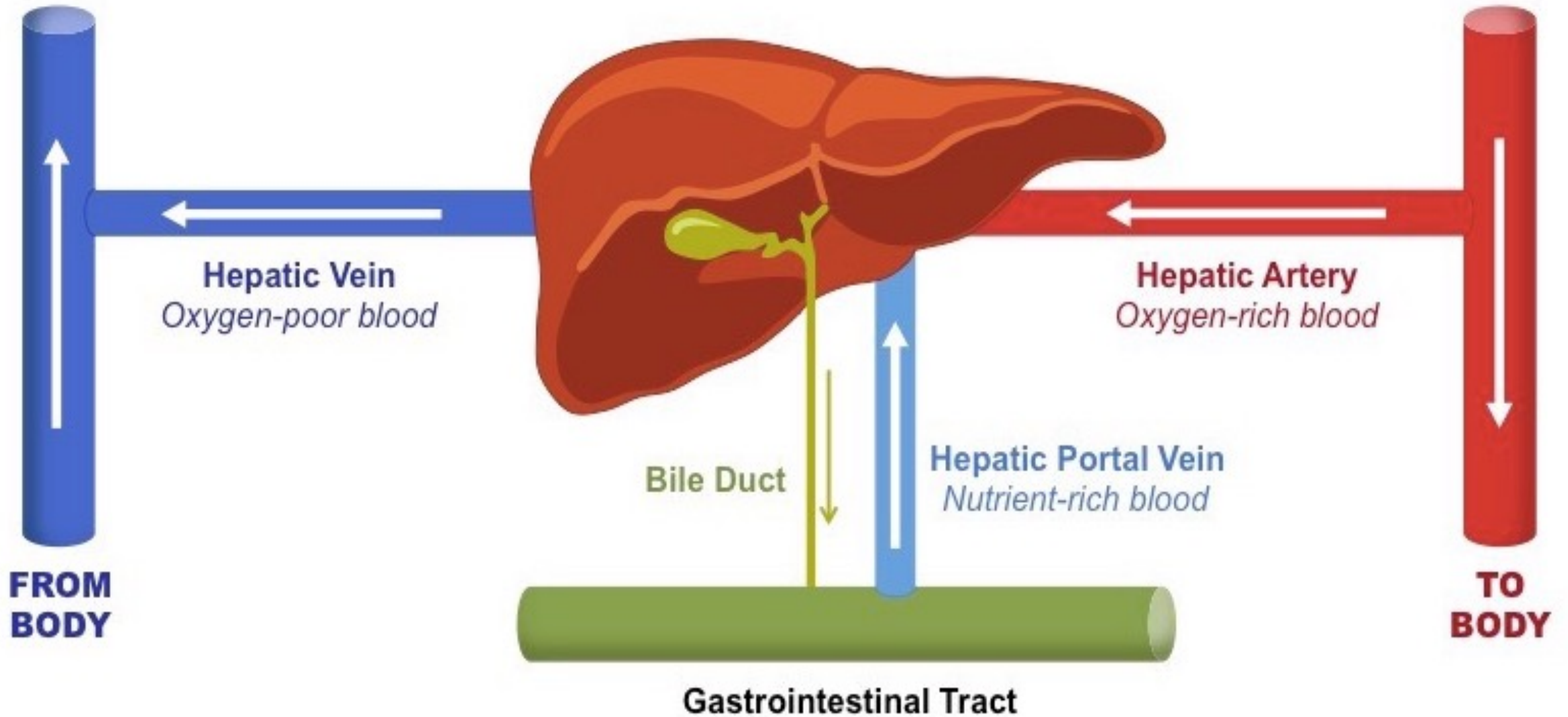


# Lobes of the Liver





# Overview of Hepatic Circulation

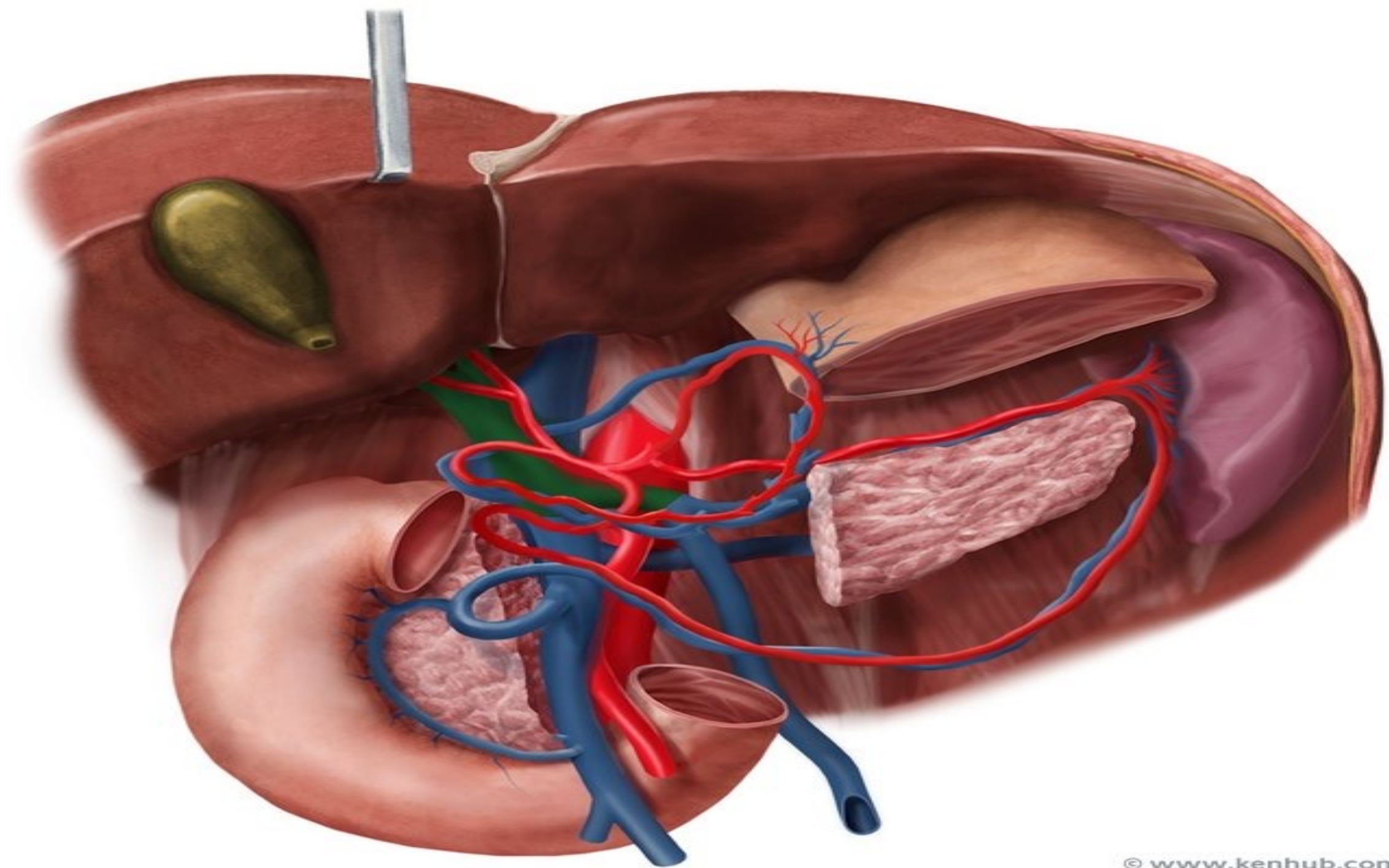


# Dual Blood Supply of Liver

- Right and left hepatic arteries (25%)
  - Oxygenated blood
- Hepatic portal vein (75%)
  - Carries almost all nutrients from GI tract
- Venous drainage
  - Hepatic veins drain venous blood to IVC
  - Left hepatic vein
  - Middle hepatic vein
  - Right hepatic vein

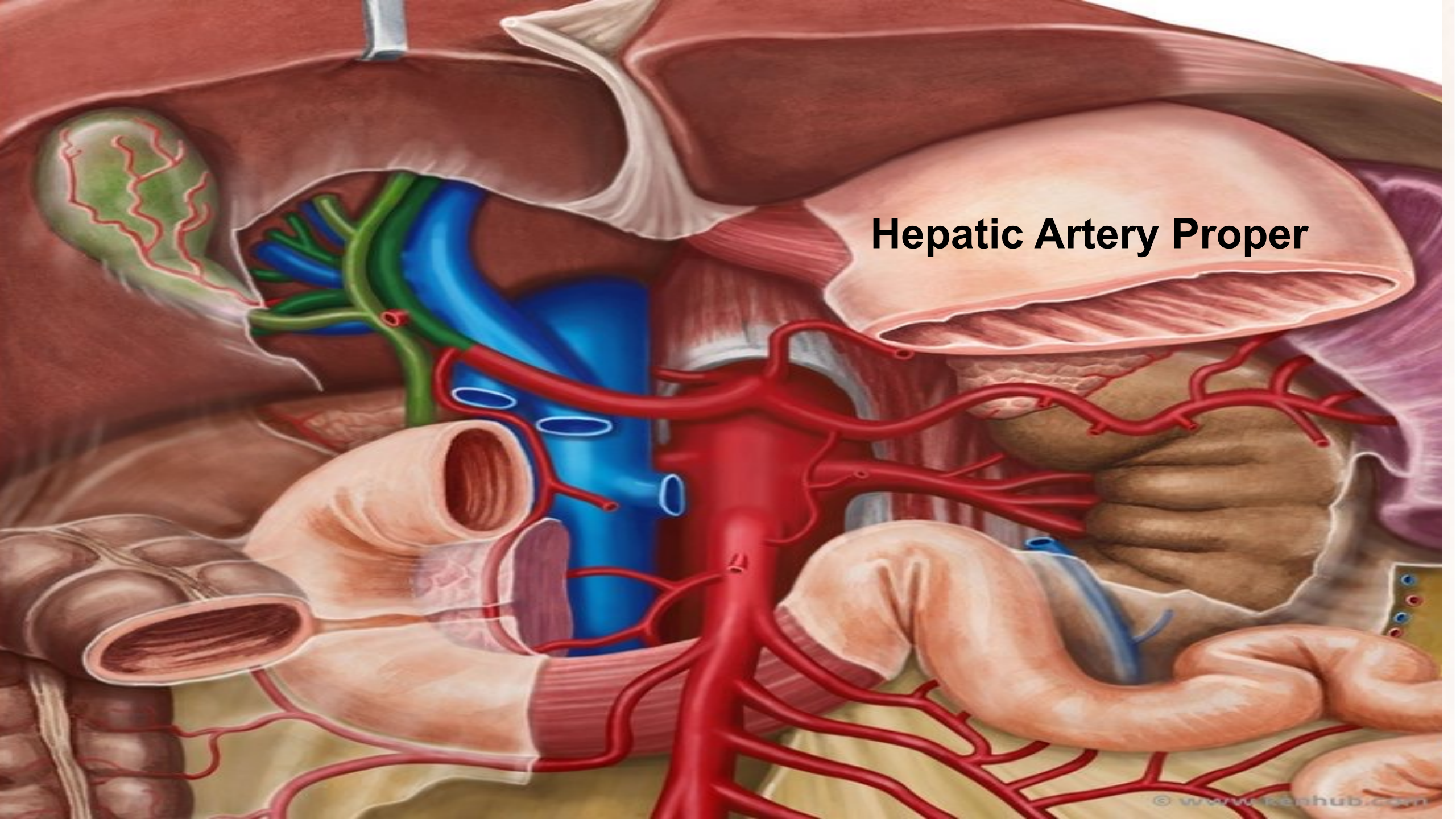
# Blood Supply of Liver

- The blood supply of the liver is delivered through the portal vein and the proper hepatic artery.
- The proper hepatic artery (arises from the celiac trunk via common hepatic artery) brings oxygenated blood to the hepatic tissues, while the portal vein collects the deoxygenated blood from the abdominal contents and filters it, eliminating toxins and processing the nutrients it collects during absorption from the alimentary canal.
- The portal venous system will be discussed below, so for now, the pathway of the proper hepatic artery, which contributes approximately 30% towards the hepatic blood supply will be mentioned.



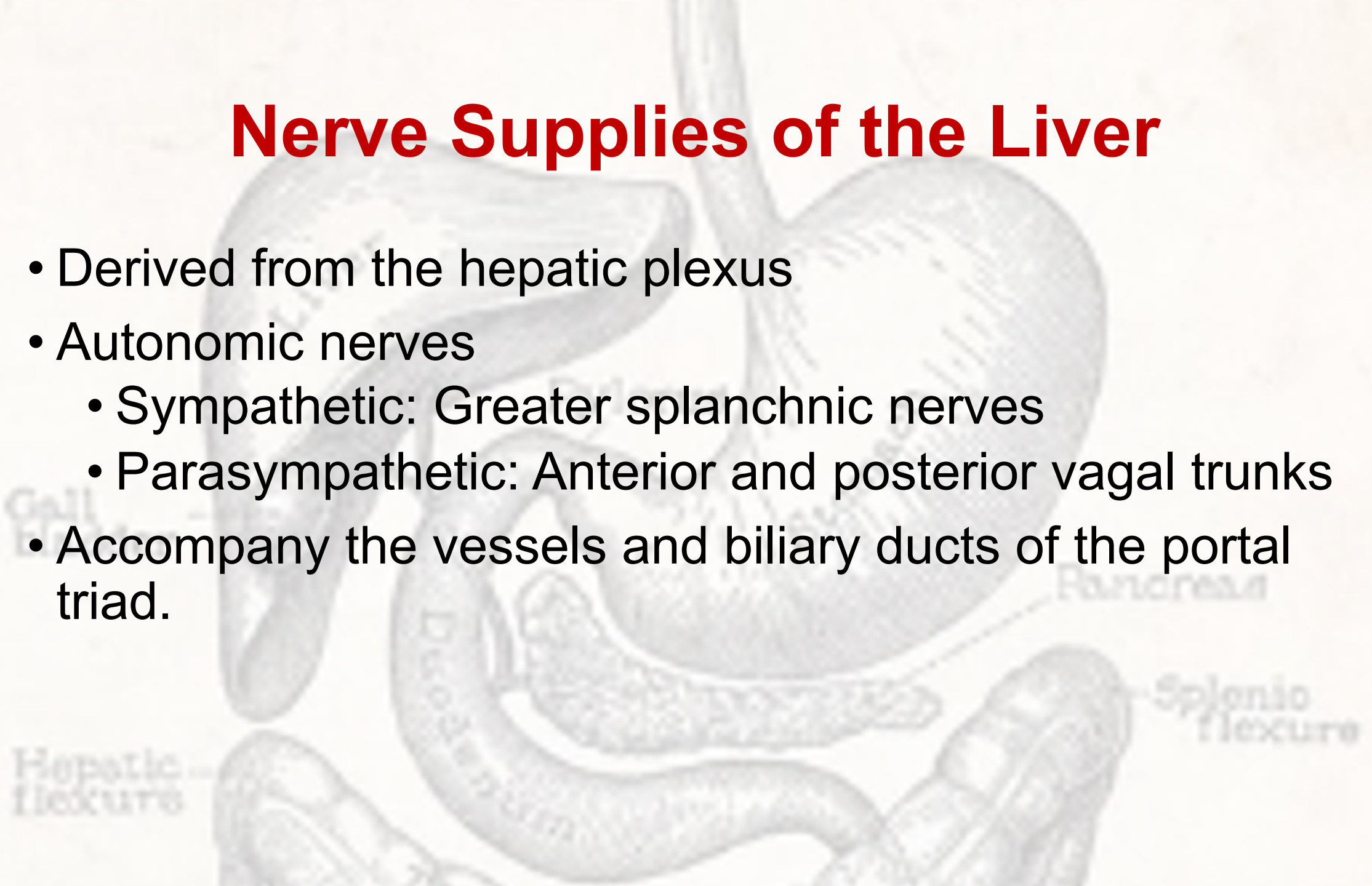


# Hepatic Artery Proper



# Nerve Supplies of the Liver

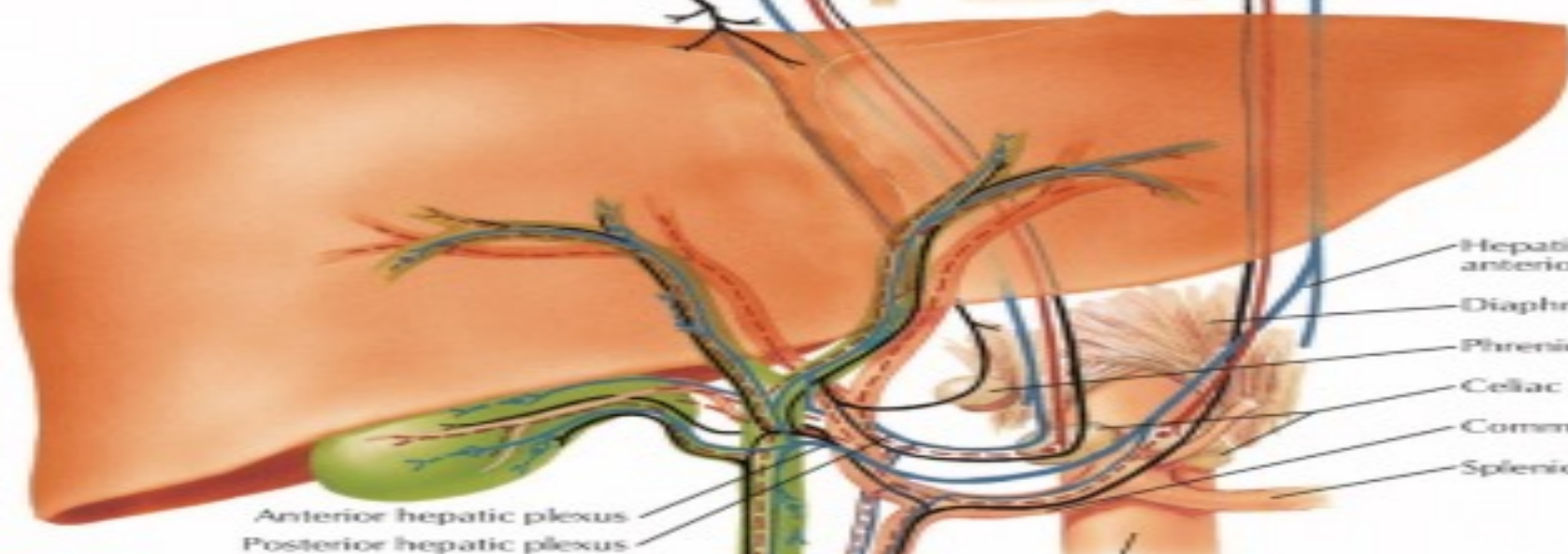
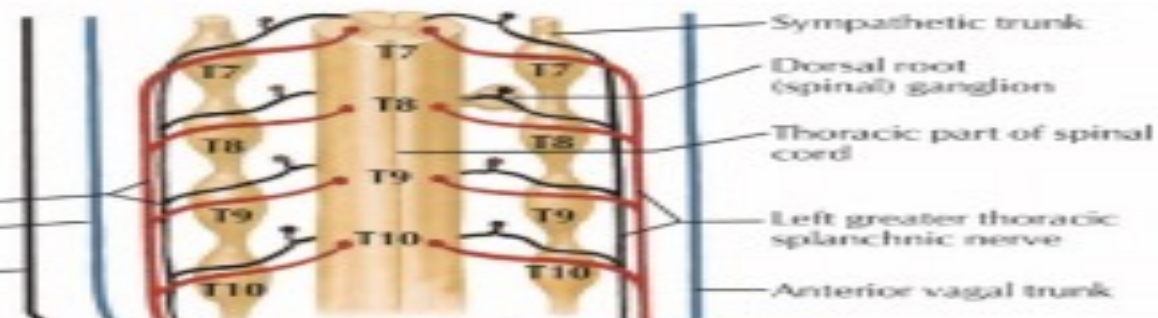
- Derived from the hepatic plexus
- Autonomic nerves
  - Sympathetic: Greater splanchnic nerves
  - Parasympathetic: Anterior and posterior vagal trunks
- Accompany the vessels and biliary ducts of the portal triad.



Common areas of referred pain in biliary disease



Right greater thoracic splanchnic nerve  
 Posterior vagal trunk  
 Right phrenic nerve to diaphragmatic part of parietal peritoneum



Hepatic branch of anterior vagal trunk  
 Diaphragm  
 Phrenic ganglion  
 Celiac ganglia  
 Common hepatic artery  
 Splenic artery

Anterior hepatic plexus  
 Posterior hepatic plexus

Aorta  
 Gastroduodenal artery and plexus

Sphincter of hepatopancreatic ampulla

**Sympathetic fibers**  
 Preganglionic ————  
 Postganglionic - - - -  
**Parasympathetic fibers**  
 Preganglionic ————  
 Postganglionic - - - -  
**Afferent fibers** ————

**Ramification of nerve fibers around fine branch of hepatic artery**



# Lymphatic Drainage

- The lymphatic drainage of the liver is split into **deep and superficial drainage systems**.
- The **deep system** consists of hepatic lymph vessels which follow the hepatic portal veins, therefore most of the lymph will flow towards the hepatic nodes at the hilum of the liver, which drain to the celiac nodes.
- These drain to the cisterna chyli (if present) and on into the thoracic duct.

Hepatic  
flexure

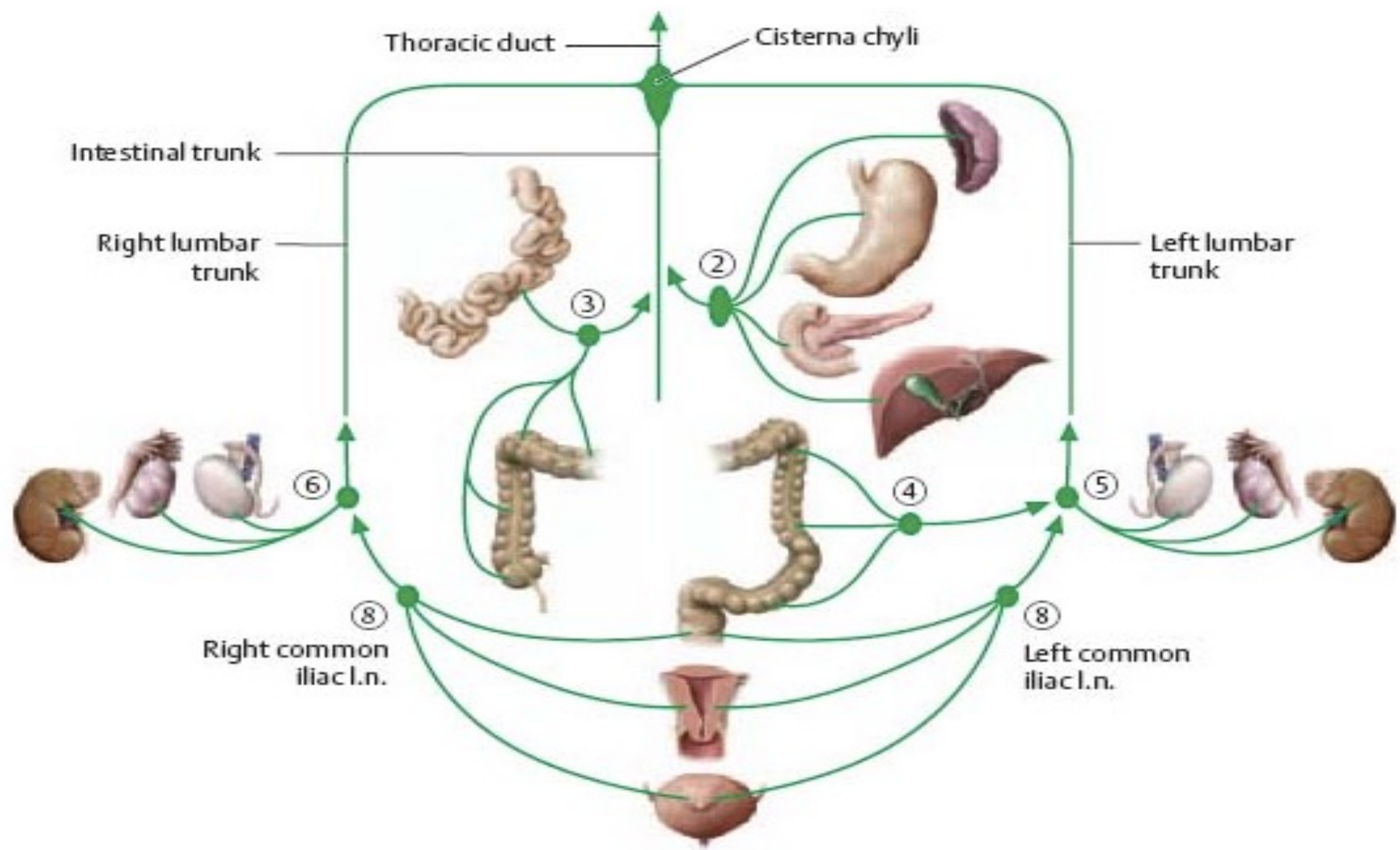
Splenic  
flexure

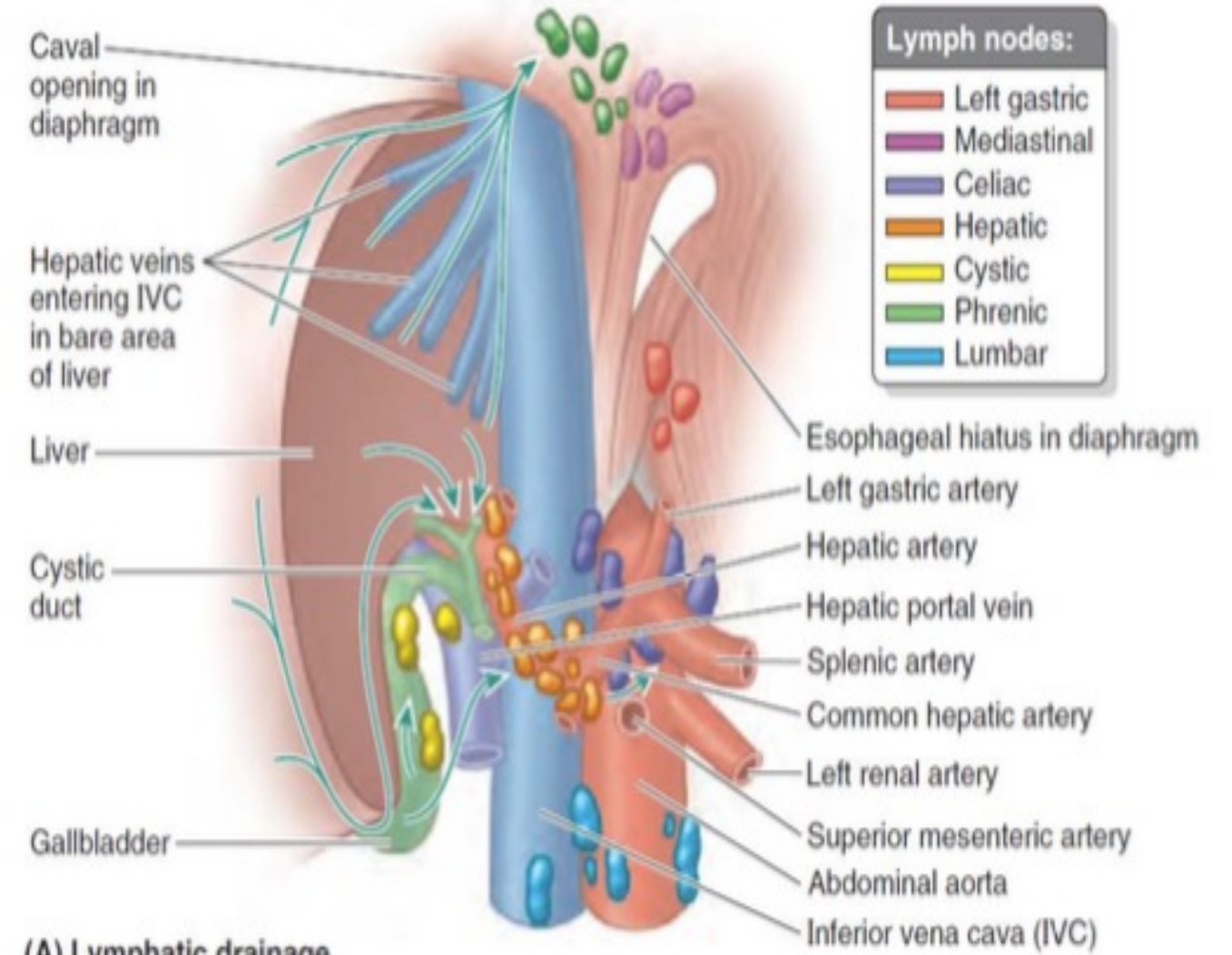
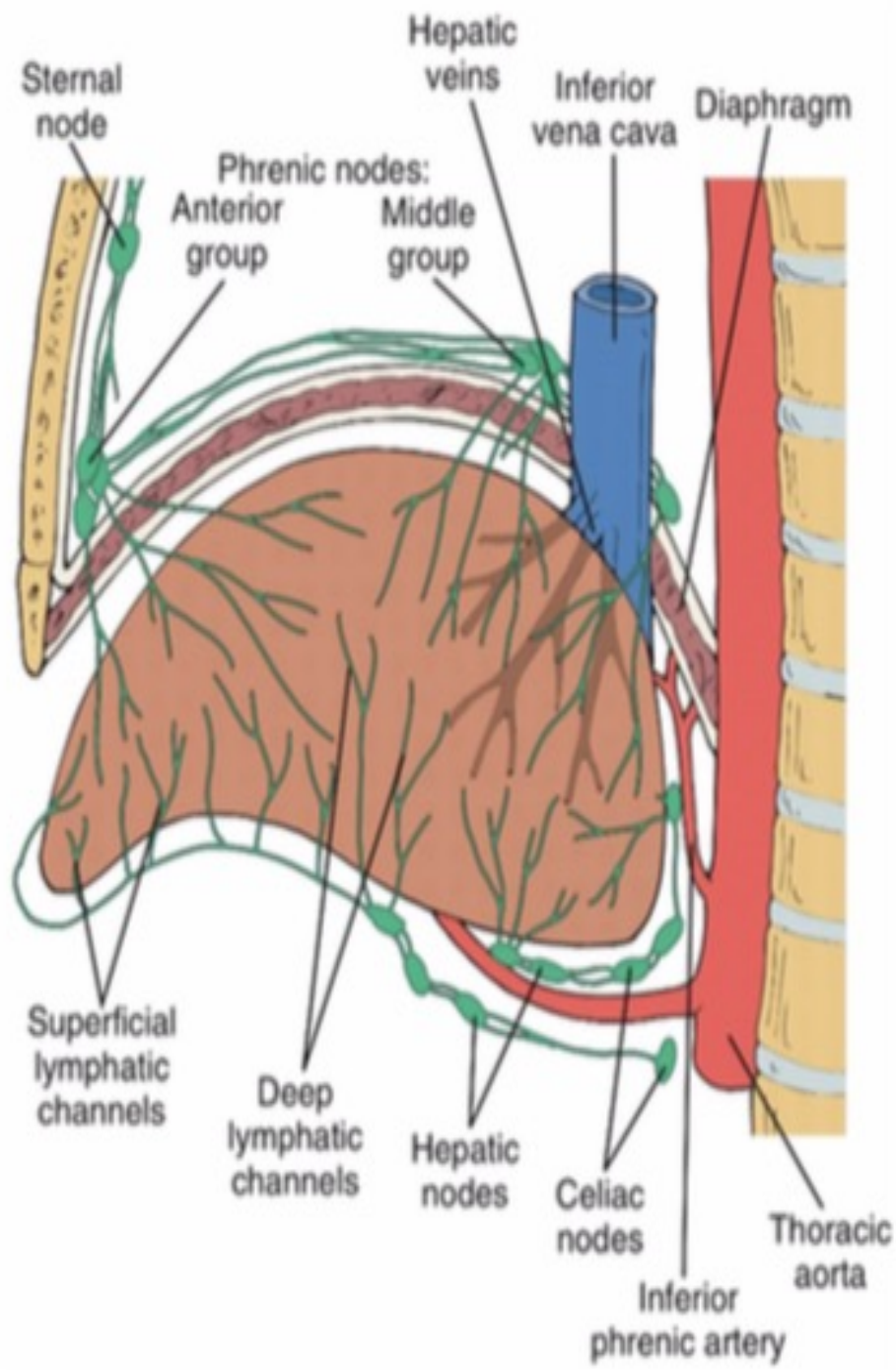
# Lymphatic Drainage

- Additional lymphatic vessels exit via the bare area following the hepatic veins as they join the inferior vena cava.
- Therefore, some the hepatic lymph vessels drain to the inferior diaphragmatic/phrenic nodes (or uppermost members of the the right lumbar lymph nodes) which drain to the right posterior mediastinal nodes.
- From there lymph flows up the right mediastinal lymphatic chain and flows into the thoracic duct.

# Lymphatic Drainage

- The **superficial system** transports lymphatic fluid through channels in the subserosal areolar tissue (Glisson's capsule) which envelopes the liver.
- The inferior, anterior and superior surfaces drain to hepatic nodes at the liver hilum.
- The right superior surface will often drain to lymph vessels following the inferior phrenic artery and connect with the celiac nodes.
- The posterior surface of the liver is conducted towards the bare area of the liver and into the inferior diaphragmatic nodes/right lumbar nodes, which drain as described above.



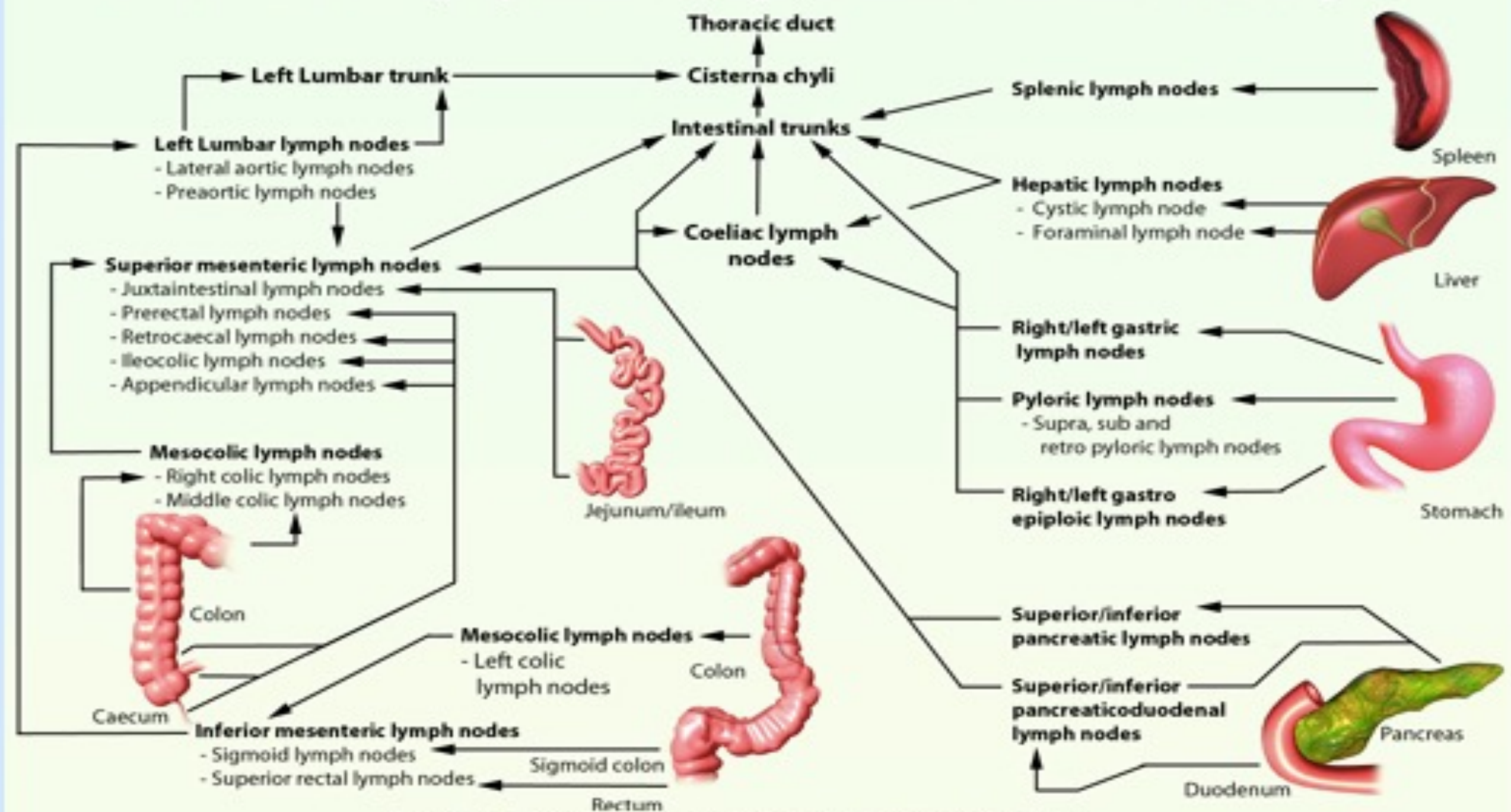


Lymph nodes:	
<span style="color: red;">█</span>	Left gastric
<span style="color: purple;">█</span>	Mediastinal
<span style="color: blue;">█</span>	Celiac
<span style="color: orange;">█</span>	Hepatic
<span style="color: yellow;">█</span>	Cystic
<span style="color: green;">█</span>	Phrenic
<span style="color: cyan;">█</span>	Lumbar

(A) Lymphatic drainage



# Overview of the Lymphatic Drainage of Abdominal and Pelvic Organs



# Composition of Bile

- A yellow-green, alkaline solution containing bile salts, bile pigments, cholesterol, neutral fats, phospholipids, and electrolytes
- Bile salts are cholesterol derivatives that:
  - Emulsify fat
  - Facilitate fat and cholesterol absorption
  - Help solubilize cholesterol
- The chief bile pigment is bilirubin, a waste product of heme

# Liver: Associated Structures

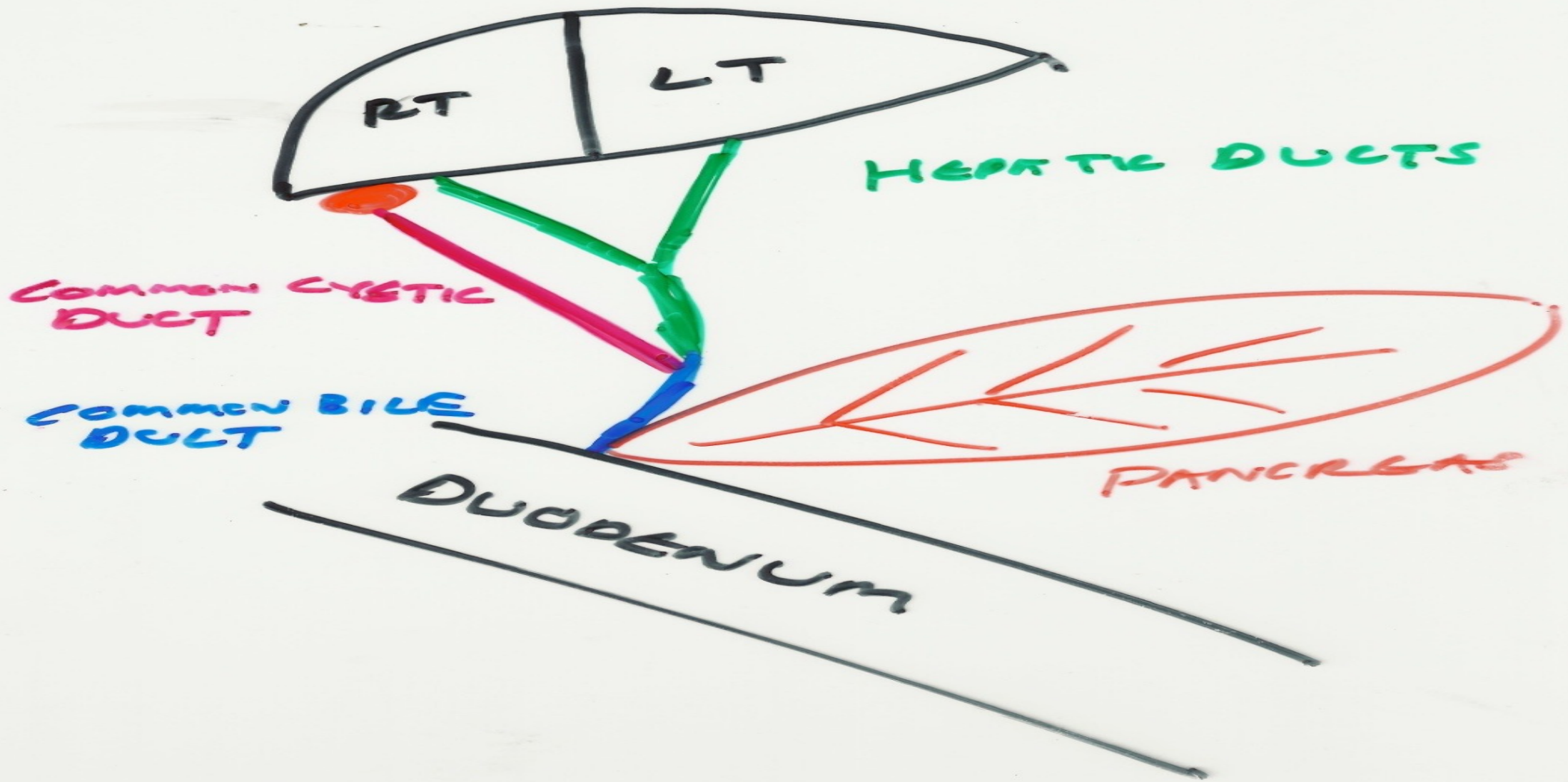
- Bile leaves the liver via:
  - Bile ducts, which fuse into the common hepatic duct
  - The common hepatic duct, which fuses with the cystic duct
    - These two ducts form the bile duct

Gall bladder

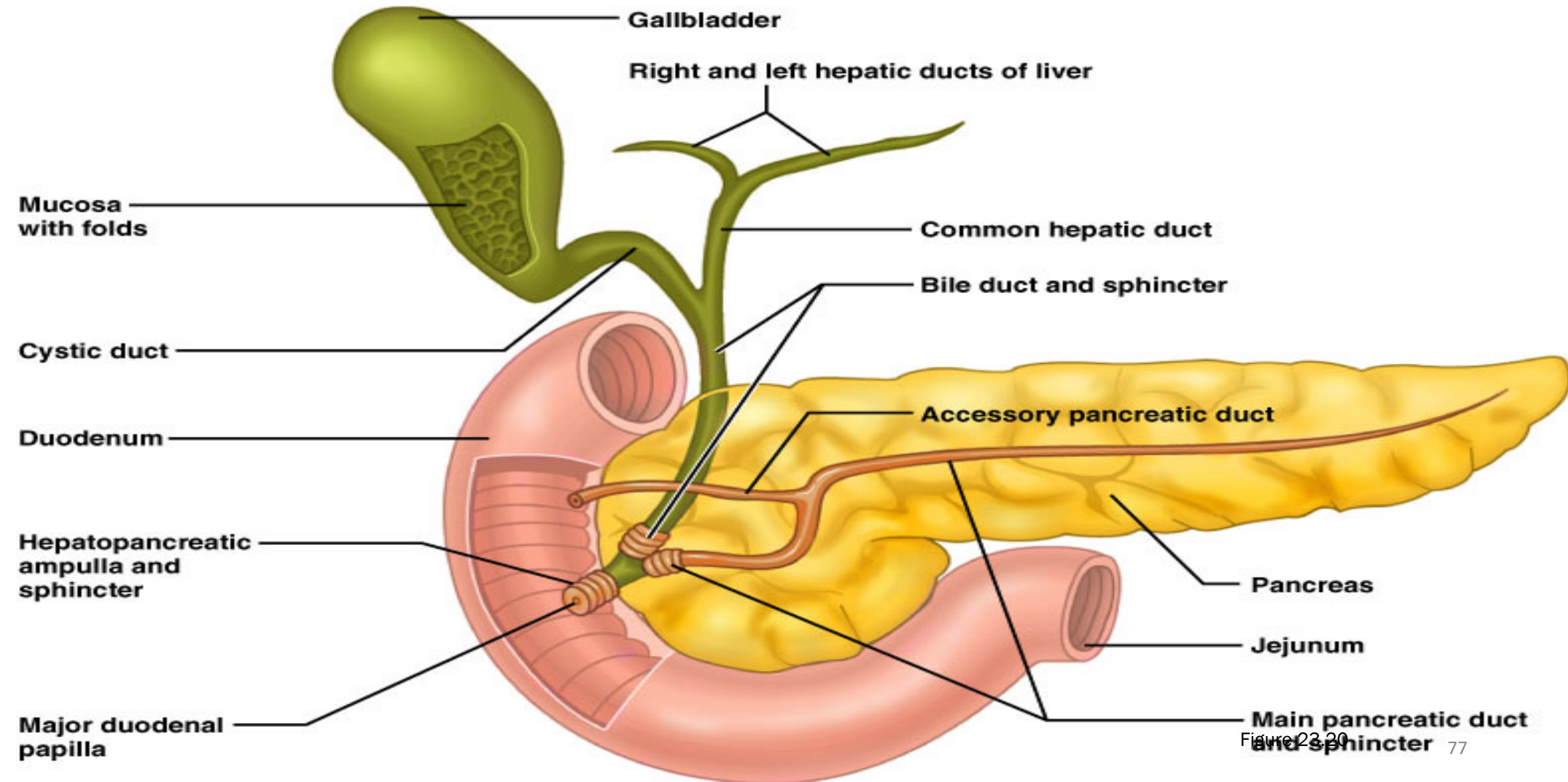
Hepatic flexure

Pancreas

Splenic flexure



# Gallbladder and Associated Ducts







Gall  
blad

Hep  
flex

Uter

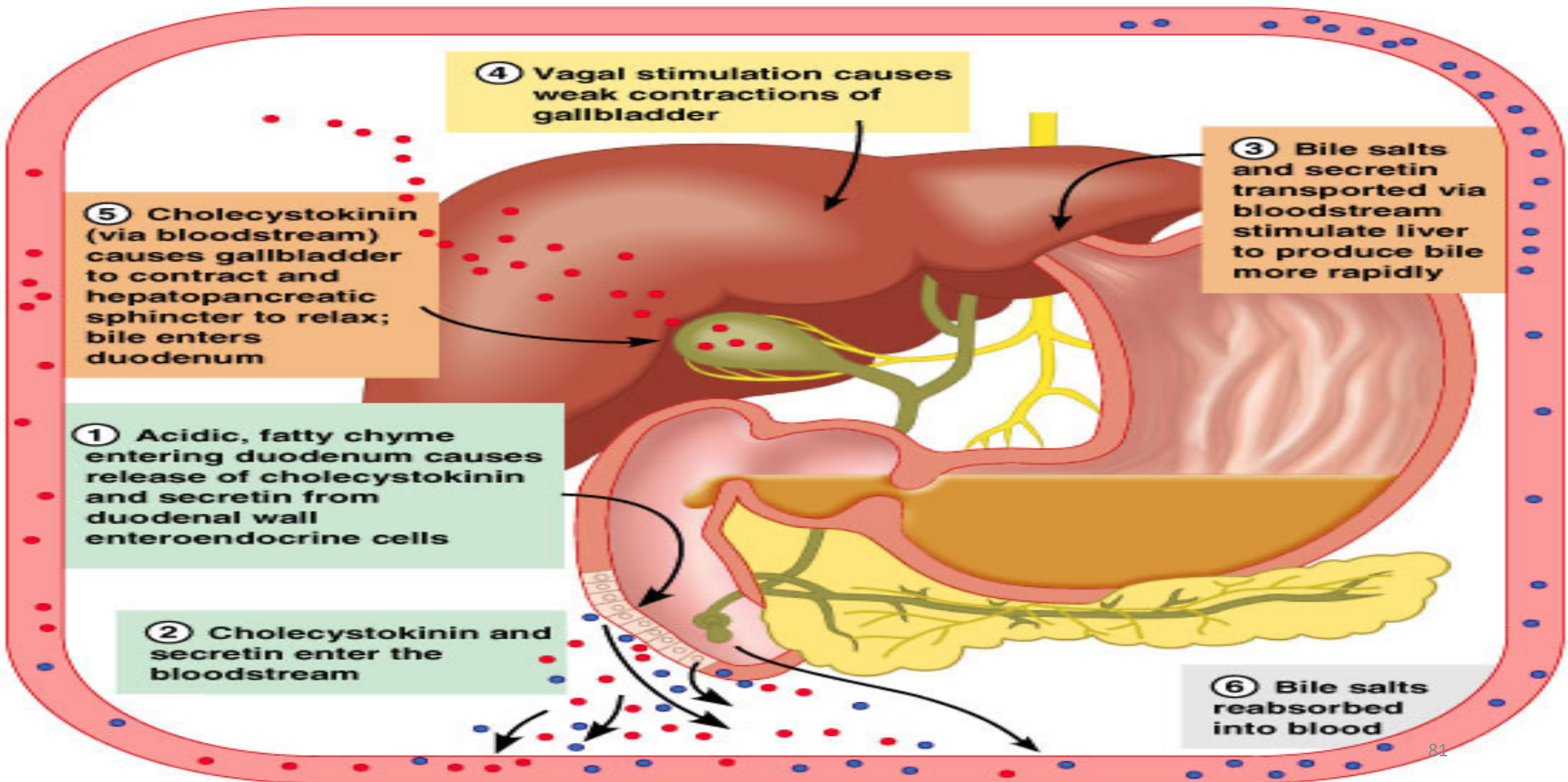


# Regulation of Bile Release

- Acidic, fatty chyme causes the duodenum to release:
  - Cholecystokinin (CCK) and secretin into the bloodstream
- Bile salts and secretin transported in blood stimulate the liver to produce bile
- Cholecystokinin causes:
  - The gallbladder to contract
  - The hepatopancreatic sphincter to relax
- As a result, bile enters the duodenum



# Regulation of Bile Release



# Bile Release





1. Digestion of food

