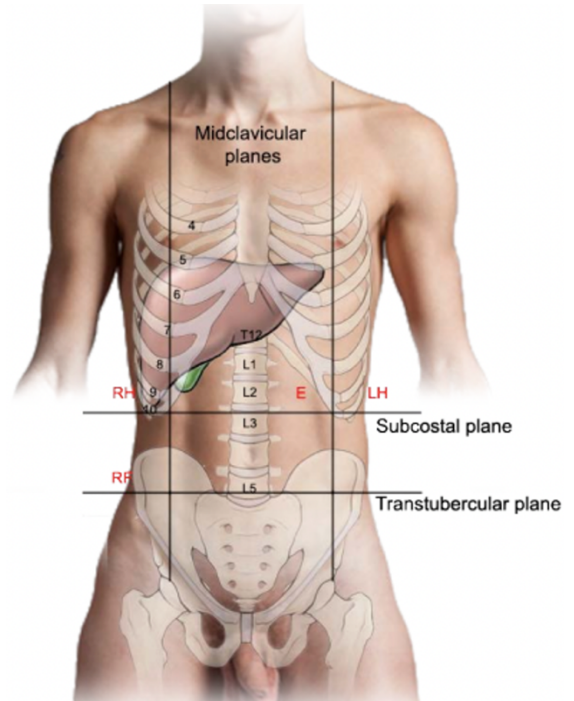


# Anatomy of the Liver, Biliary Tract, and Portal Venous System

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## Liver

- Intra-peritoneal organ
- The largest gland in the body
  - Weight 1500 gm – 3 ½#
  - 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.
- 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
- 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
- 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

## Palpation of Liver

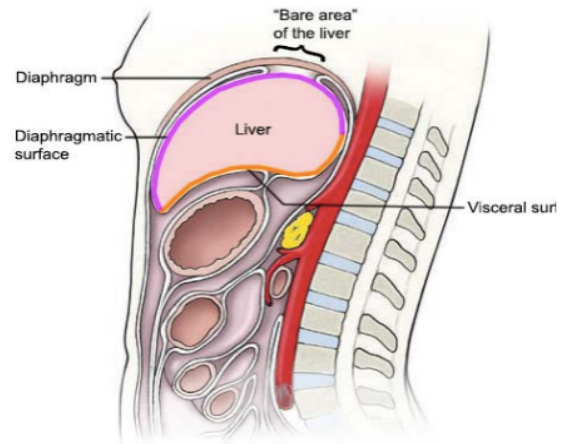
- The liver may be palpated in a supine person because of the inferior movement of the diaphragm and liver that accompanies deep inspiration.
- One method of palpating the liver is to place the left hand posteriorly behind the lower rib cage.
- Put the right hand on the person's right upper quadrant, 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.

## Surface Projection

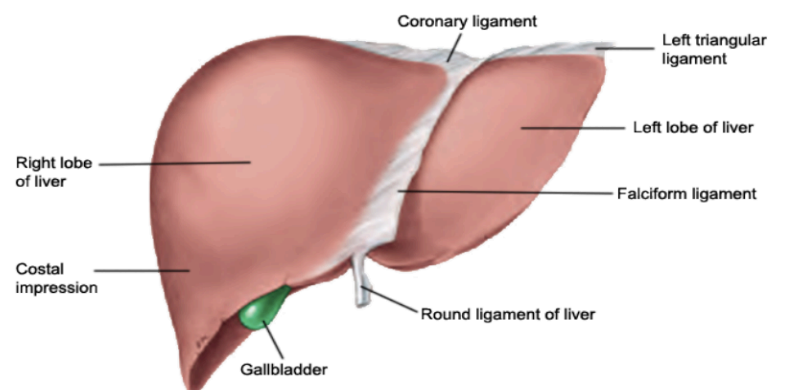
- Uppermost: Right mid-inguinal line
- Right 5th rib
- Right lowermost: Right midaxillary line
- Right 10th costal cartilage
- Left lowermost: Left mid-inguinal line
- Left 5th intercostal space (ICS)

## Surface of the Liver

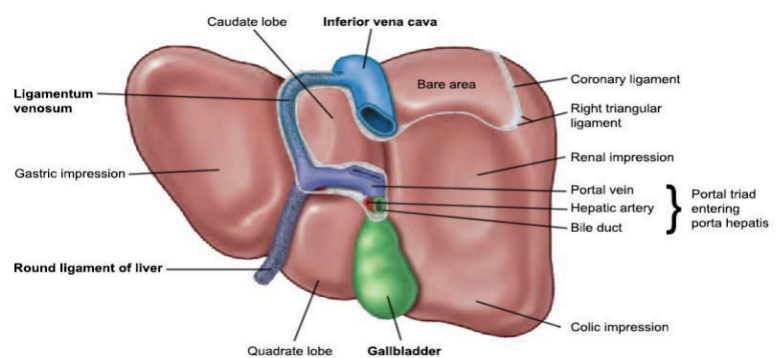
- Diaphragmatic surface
  - Anterosuperior surface
  - Convex surface
  - Relate to inferior surface of diaphragm
- Visceral surface
  - Posteroinferior surface
  - Concave surface
  - Relate to abdominal organ



### Diaphragmatic Surface



### Visceral Surface



## Visceral Surface of the Liver

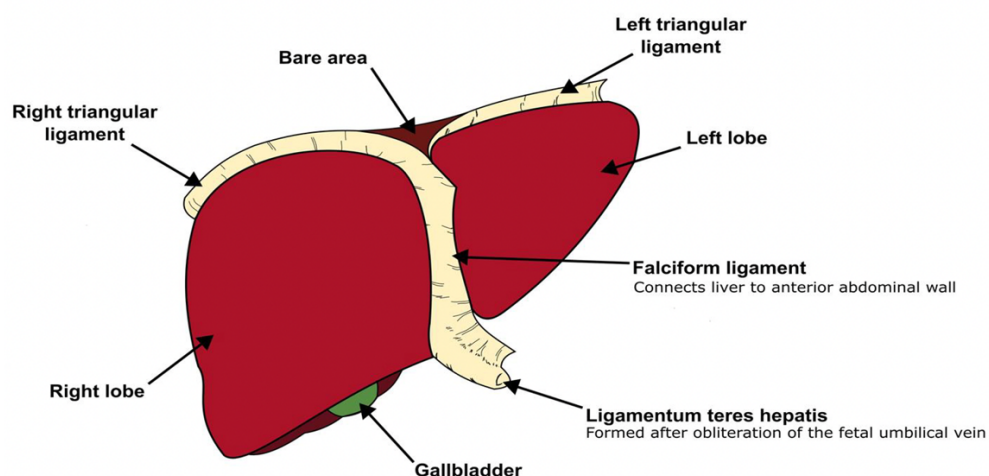
- Porta hepatis – Hepatic artery, Portal vein, Bile duct, Nerves and Lymphatic vessels
- Ligamentum teres hepatis (round ligament of liver) – Remnant of umbilical vein
- Ligamentum venosum – Remnant of ductus venosus
- Gallbladder
- Inferior vena cava

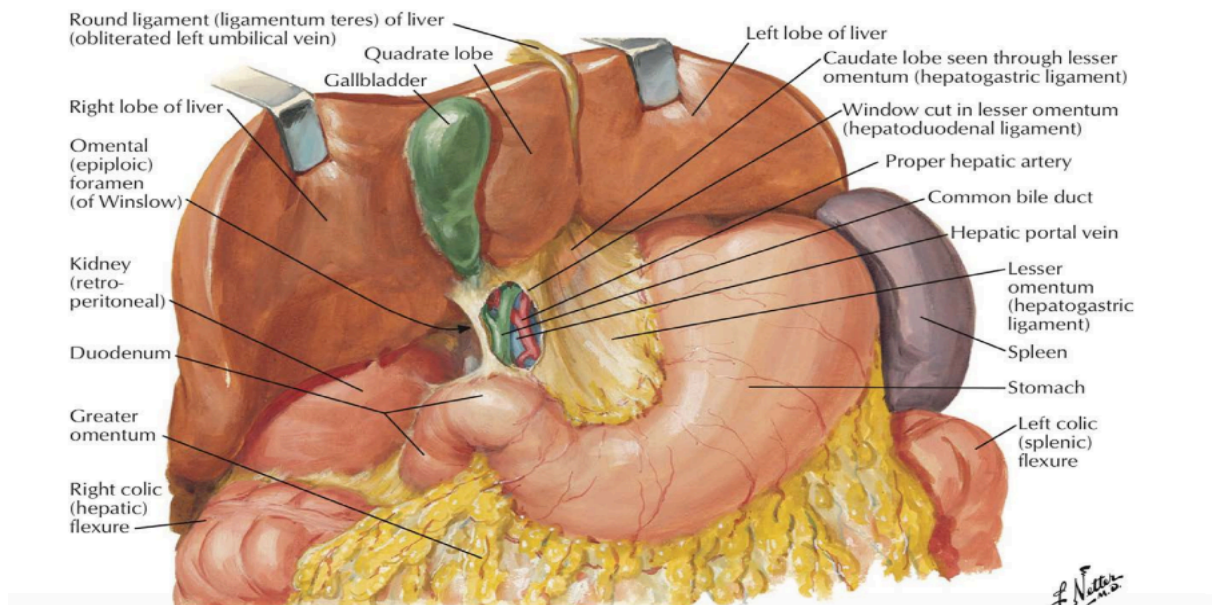
## Peritoneal Relationships

- “Glisson’s capsule”
  - Capsule of the liver
  - Dense layer of fibrous connective tissue
- Visceral peritoneum covers the liver, except “bare areas”

## Ligaments of the Liver

- Peritoneal ligaments
  - Lesser omentum
  - Falciform ligament
  - Coronary ligaments
  - Triangular ligaments
- Vascular remnants
  - Round ligament of the liver (remnant of umbilical vein)
  - Ligamentum venosum (remnant of ductus venosus)





### Lesser Omentum

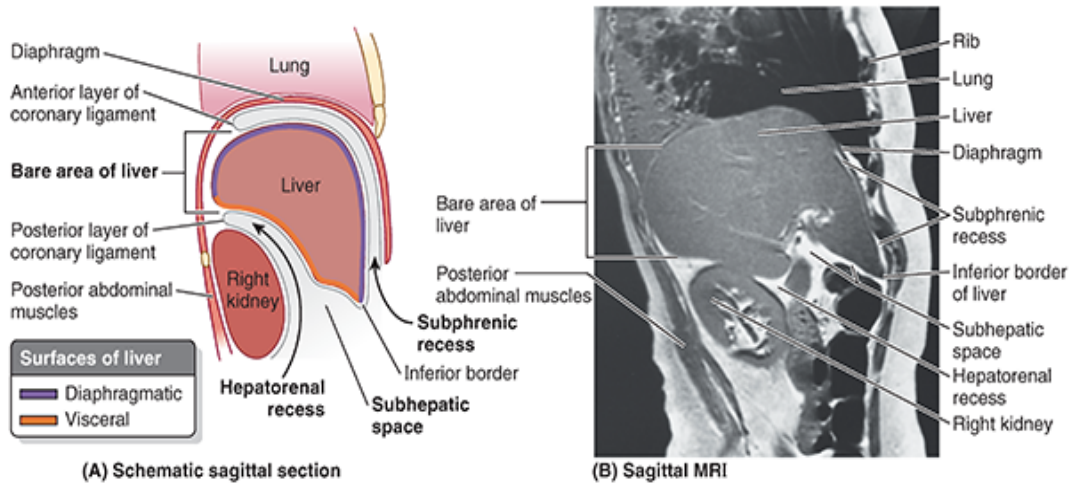
- Hepatoduodenal ligament
  - Between porta hepatis and superior aspect of 1st part of duodenum
  - Enclosing portal triad
- Hepatogastric ligament
  - Between groove for ligamentum venosum and lesser curvature of stomach

### Liver Ligaments

- Falciform Ligament
  - Attaches the anterior surface of the liver to the anterior abdominal wall.
  - Its free edge 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.
- 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.

### 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



### What is Morrison's Pouch?

- Morrison's pouch is an area between the liver and right kidney.
- It's also called the hepatorenal recess or right subhepatic space.
- Morrison'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 Morrison's pouch on an ultrasound to help diagnose conditions that cause fluid buildup in your abdomen.

### 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

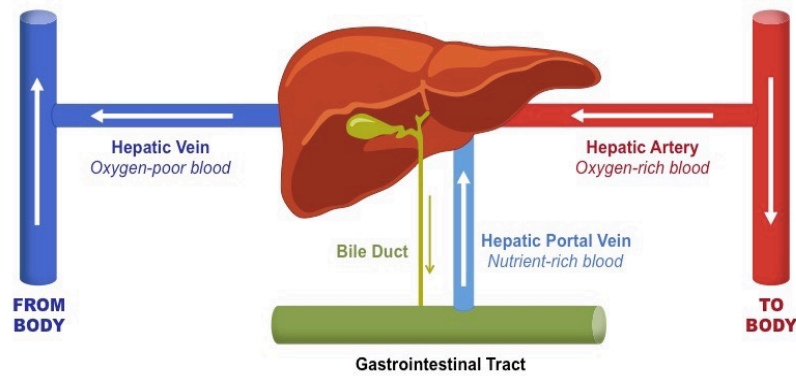
### Lobes and Segments of the Liver

- 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).
- Externally, the liver is divided into two anatomical lobes and two accessory lobes by the reflections of peritoneum from its surface, the fissures formed in relation to those reflections and the vessels serving the liver and the gallbladder.
- These superficial "lobes" are not true lobes as the term is generally used in relation to glands and are only secondarily related to the liver's internal architecture.
- The essentially midline plane defined by the attachment of the falciform ligament, and the left sagittal fissure separates a large right lobe from a much smaller left lobe.
- The liver has functionally independent right and left livers (parts or portal lobes) that are much more equal in size than the anatomical lobes.
- The liver can be further subdivided into four divisions and then into eight surgically resectable hepatic segments, each served independently by a secondary or tertiary branch of the portal triad.

### 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

## Overview of Hepatic Circulation

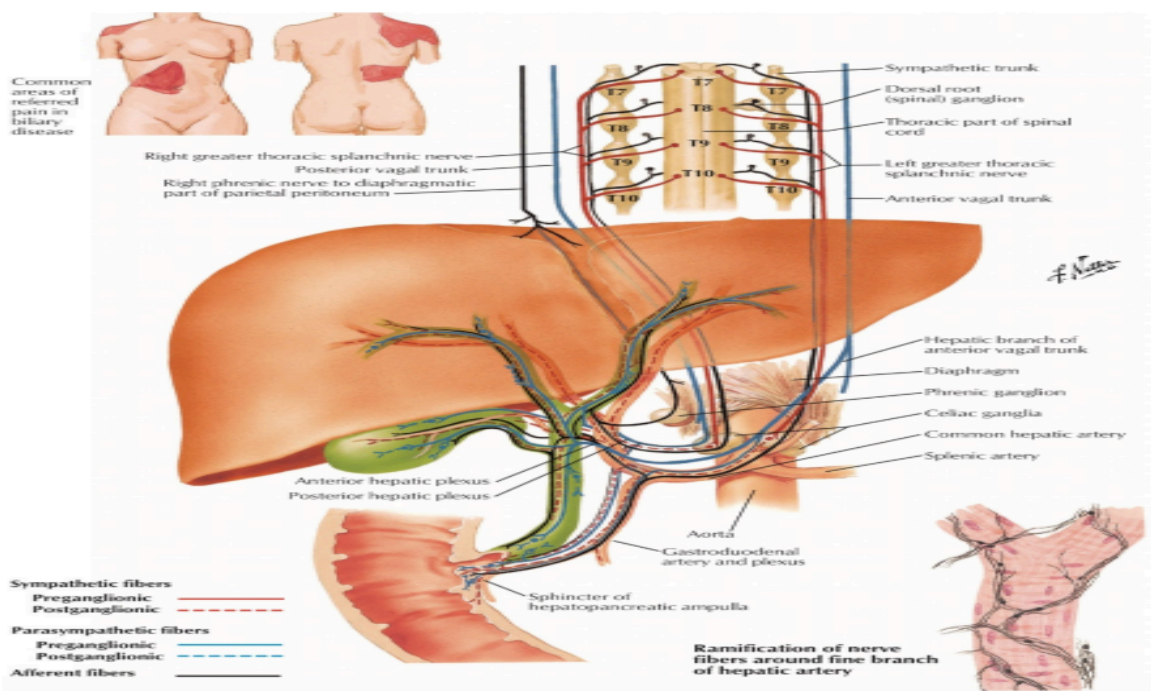


### Blood Supply of Liver

- 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.

### 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.

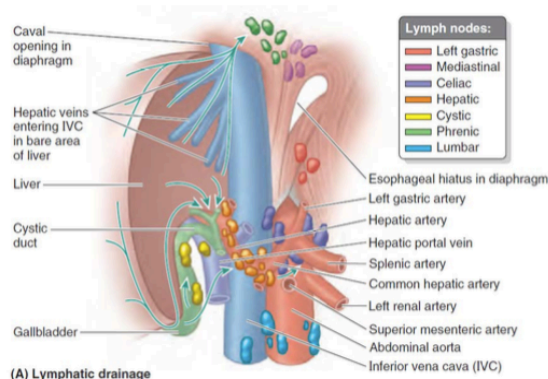
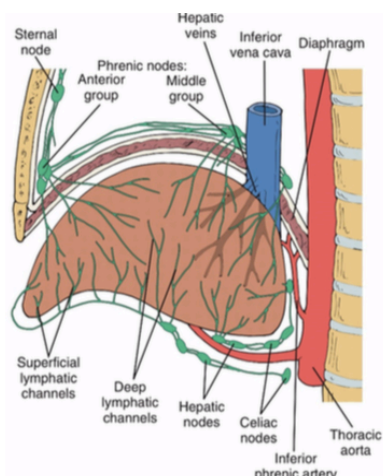


### Lymphatic Drainage

- 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.
- 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 right lumbar lymph nodes) which drain to the right posterior mediastinal nodes.

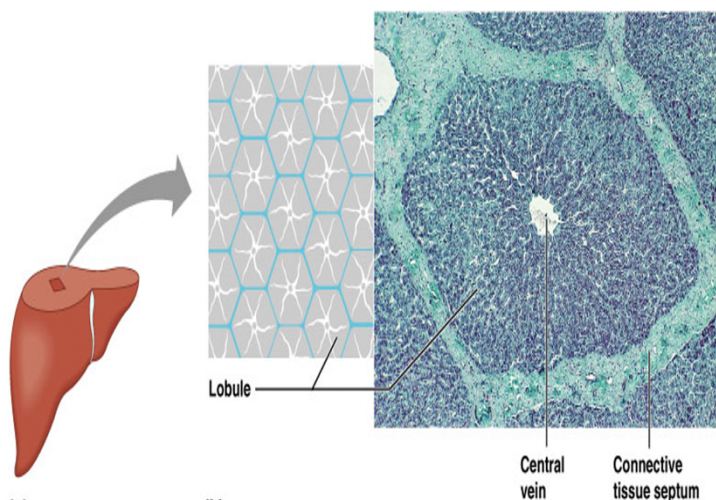
## Lymphatic Drainage

- From there lymph flows up the right mediastinal lymphatic chain and flows into the thoracic duct.
- 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.



## Liver: Microscopic Anatomy

- Hexagonal-shaped liver lobules are the structural and functional units of the liver
  - Composed of hepatocyte (liver cell) plates radiating outward from a central vein
  - Portal triads are found at each of the six corners of each liver lobule
- Portal triads consist of a bile duct and
  - Hepatic artery – supplies oxygen-rich blood to the liver
  - Hepatic portal vein – carries venous blood with nutrients from digestive vi
- Hepatocytes' functions include:
  - Production of bile
  - Processing bloodborne nutrients
  - Storage of fat-soluble vitamins
  - Detoxification

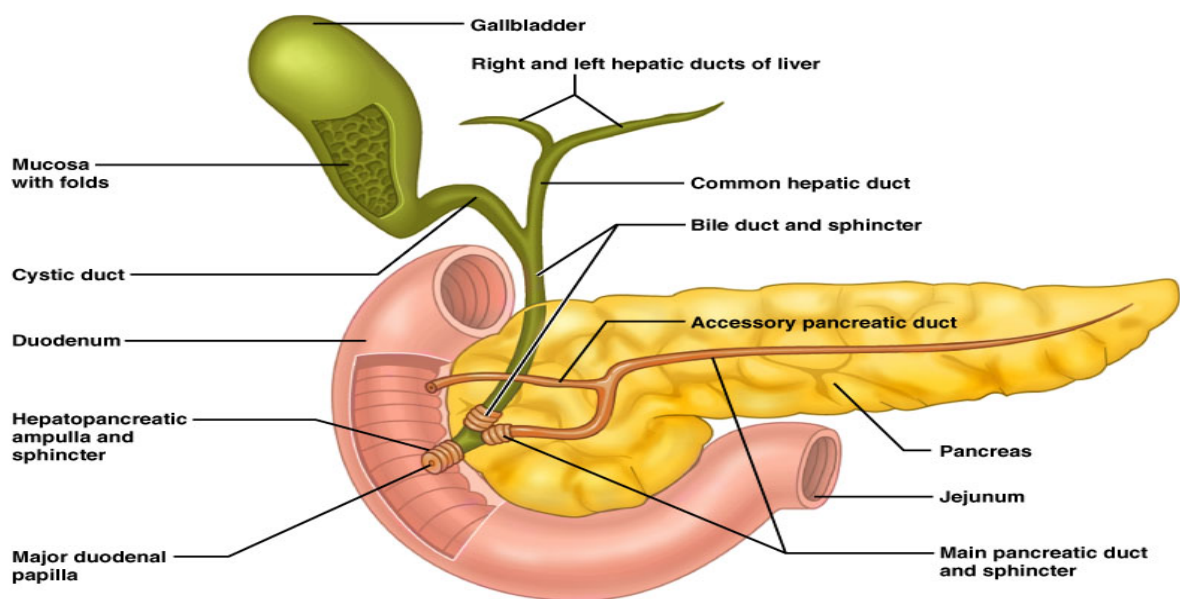


## Composition of Bile

- 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



### Regulation of Bile Release

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