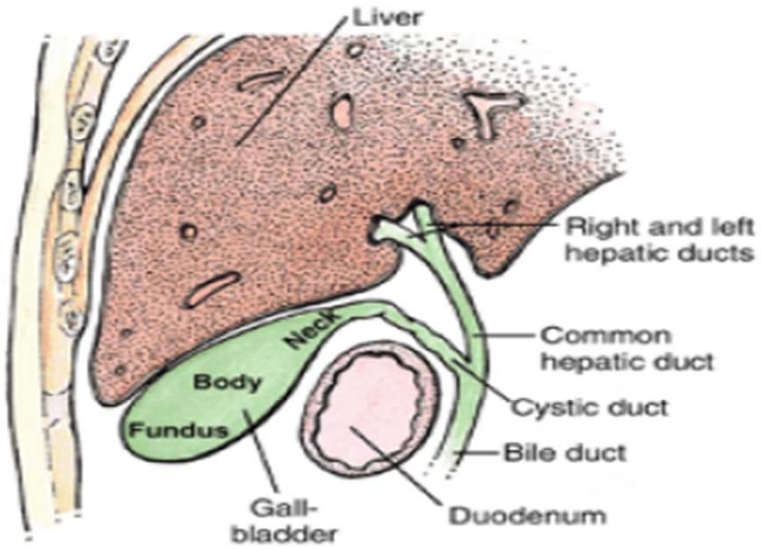
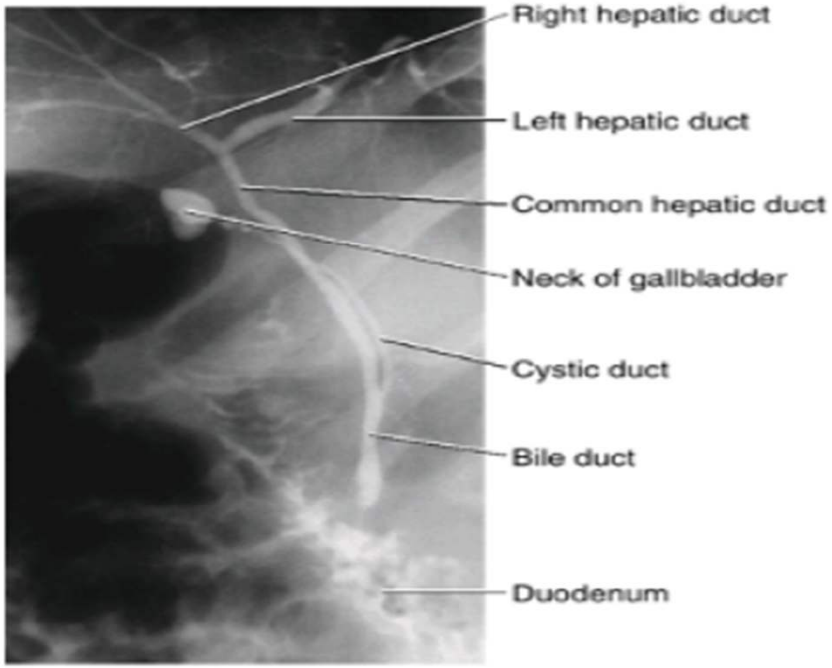


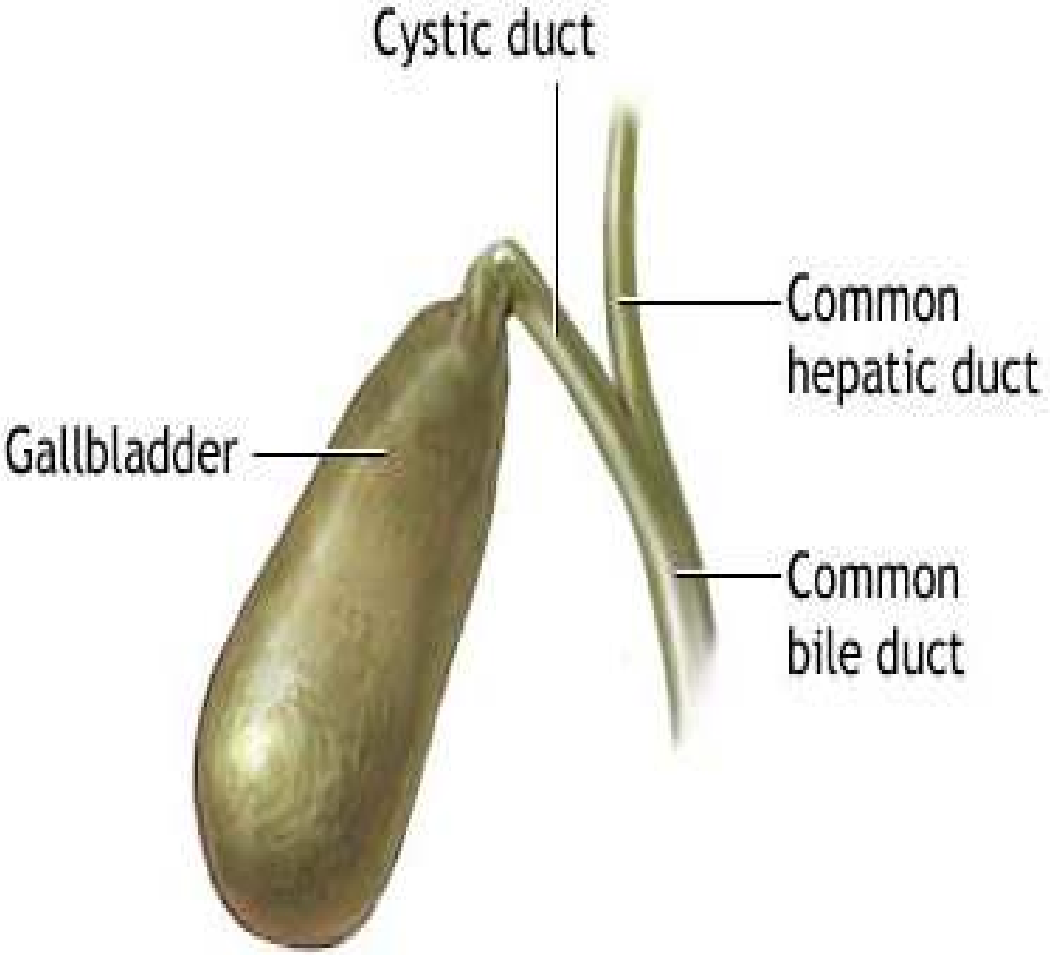
B Sagittal section



C Anterior view

BILE PHYSIOLOGY

D. HAMMOUDI, MD



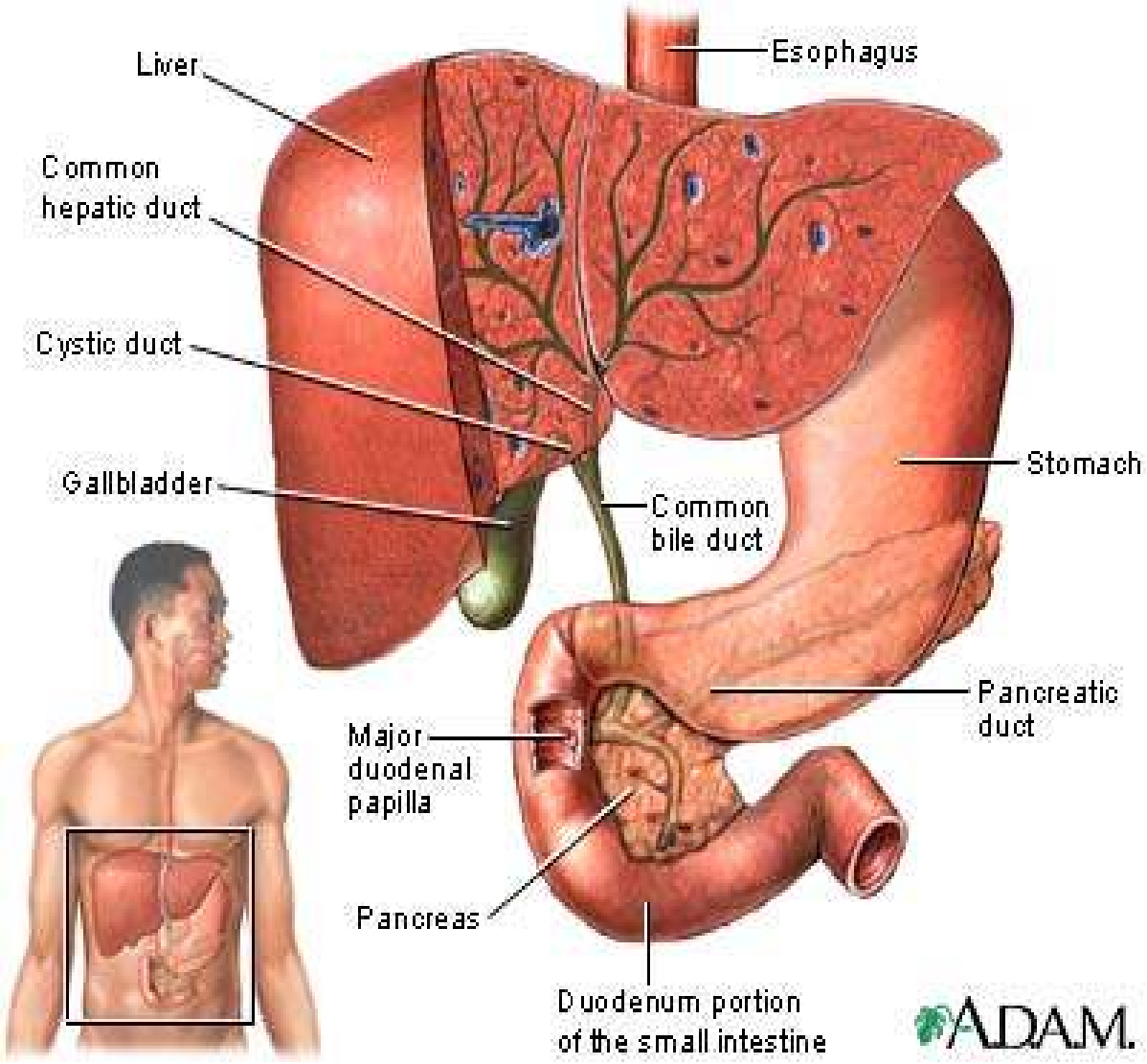
Sac to hold bile

Three layers:

- *Serous - outer*
- *Fibrous/muscular*
- *Mucousal – inner*

Has three parts:

- *Fundus*
- *Body*
- *Neck*

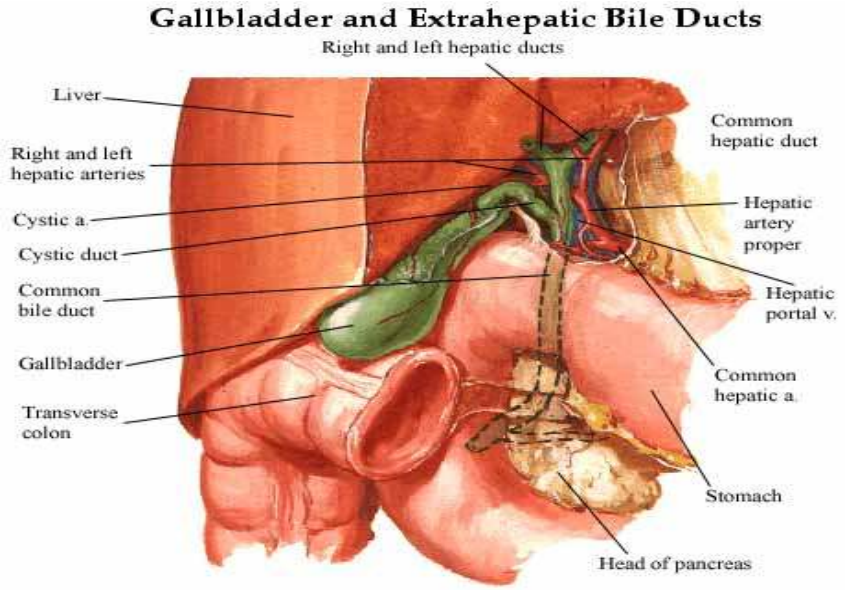


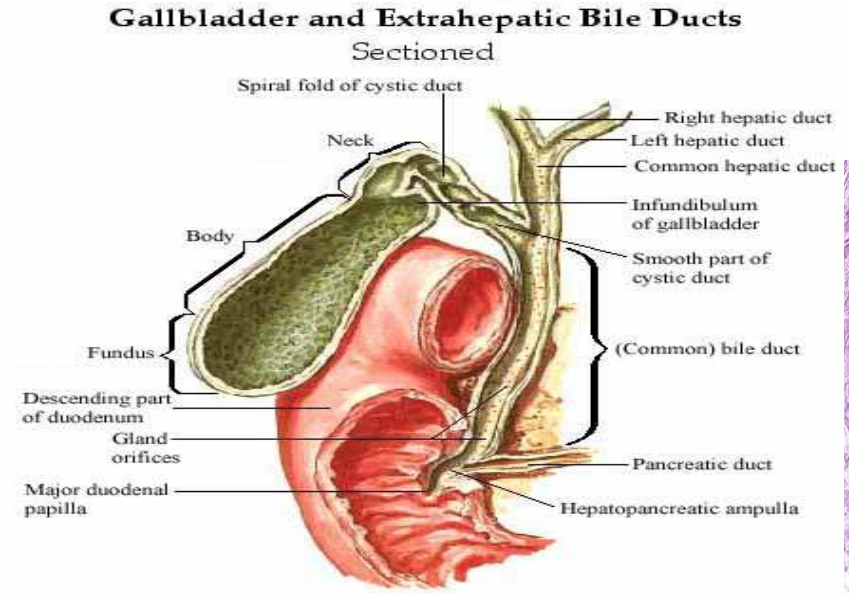
Located in right hypochondriac region.

It is a pear-shaped sac from 7-10cm long and 3cm broad at its widest point. Can hold 30-50 ml of bile.

Divided into four anatomic portions:

- ***the fundus,***
- ***the corpus or body,***
- ***infundibulum,***
- ***the neck.***





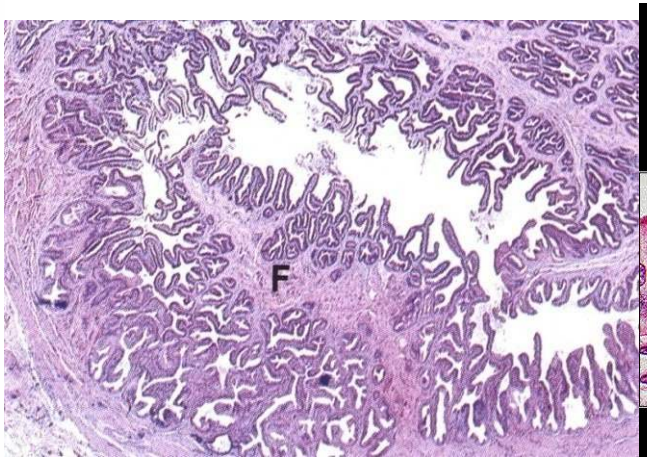
-Note the **right** and **left hepatic ducts** coming together as the **common hepatic duct**, joining the **cystic duct** to form the **common bile duct**. This descends to the 2nd part of the duodenum, is joined by the **pancreatic duct**, and empties its contents into the duodenal lumen via the **major duodenal papilla**.

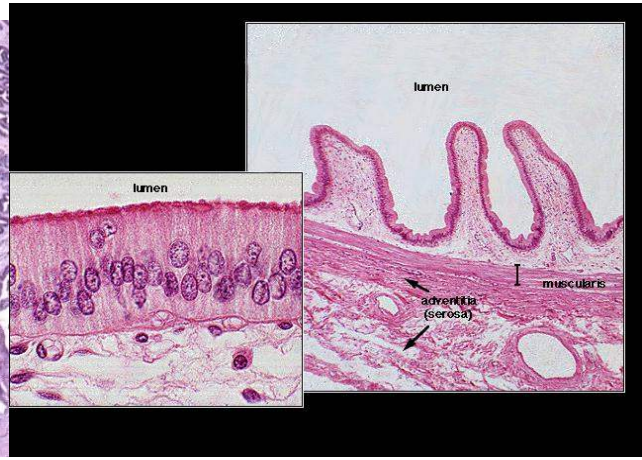
-Note the extensive folds of mucosa extending into the lumen, consisting of **tall, simple columnar epithelium**.

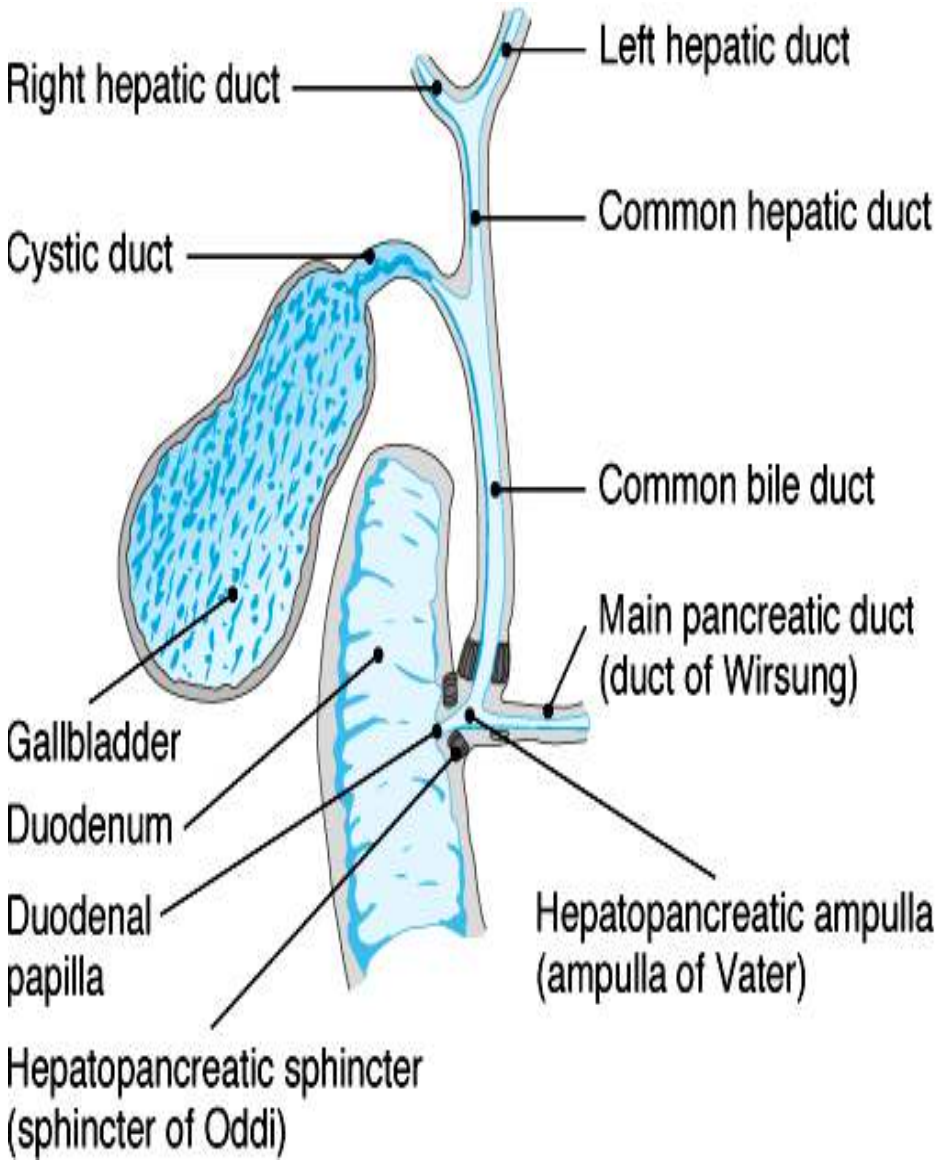
-The underlying connective tissue is comprised of lamina propria, with no distinctly defined submucosa.

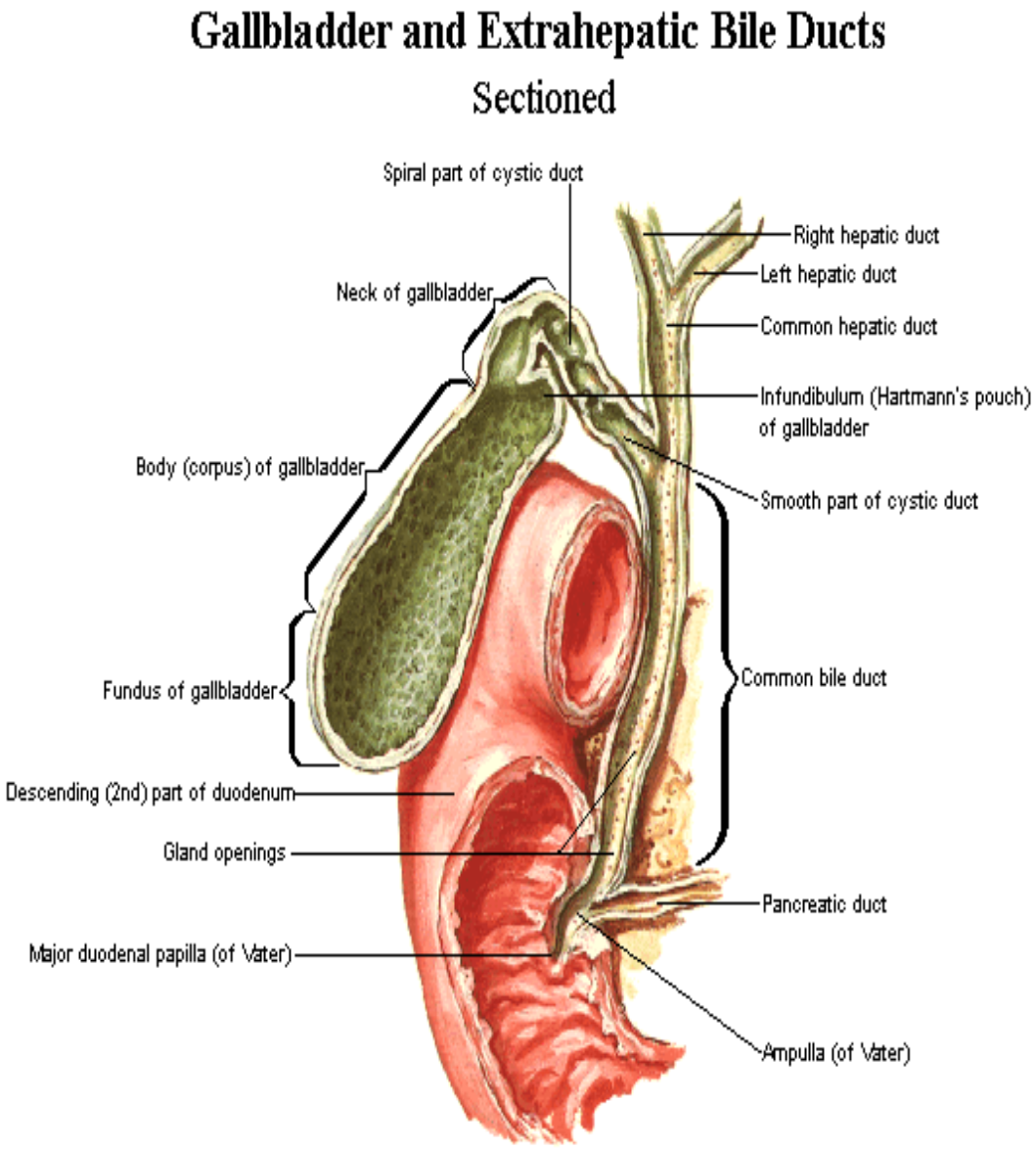
-There are scattered bundles of smooth muscle in the muscularis.

-The adventitia has rather dense connective tissue connecting the gallbladder to the liver.






Left hepatic duct
Right hepatic duct
Common hepatic duct
Cystic duct
Common bile duct
Main pancreatic duct
(duct of Wirsung)
Gallbladder
Duodenum
Duodenal
papilla
Hepatopancreatic ampulla
(ampulla of Vater)
Hepatopancreatic sphincter
(sphincter of Oddi)


Gallbladder and Extrahepatic Bile Ducts
Sectioned
Spiral part of cystic duct
Right hepatic duct
Left hepatic duct
Neck of gallbladder
Common hepatic duct
Infundibulum (Hartmann's pouch)
of gallbladder
Body (corpus) of gallbladder
Smooth part of cystic duct
Common bile duct
Fundus of gallbladder
Descending (2nd) part of duodenum
Gland openings
Pancreatic duct
Major duodenal papilla (of Vater)
Ampulla (of Vater)

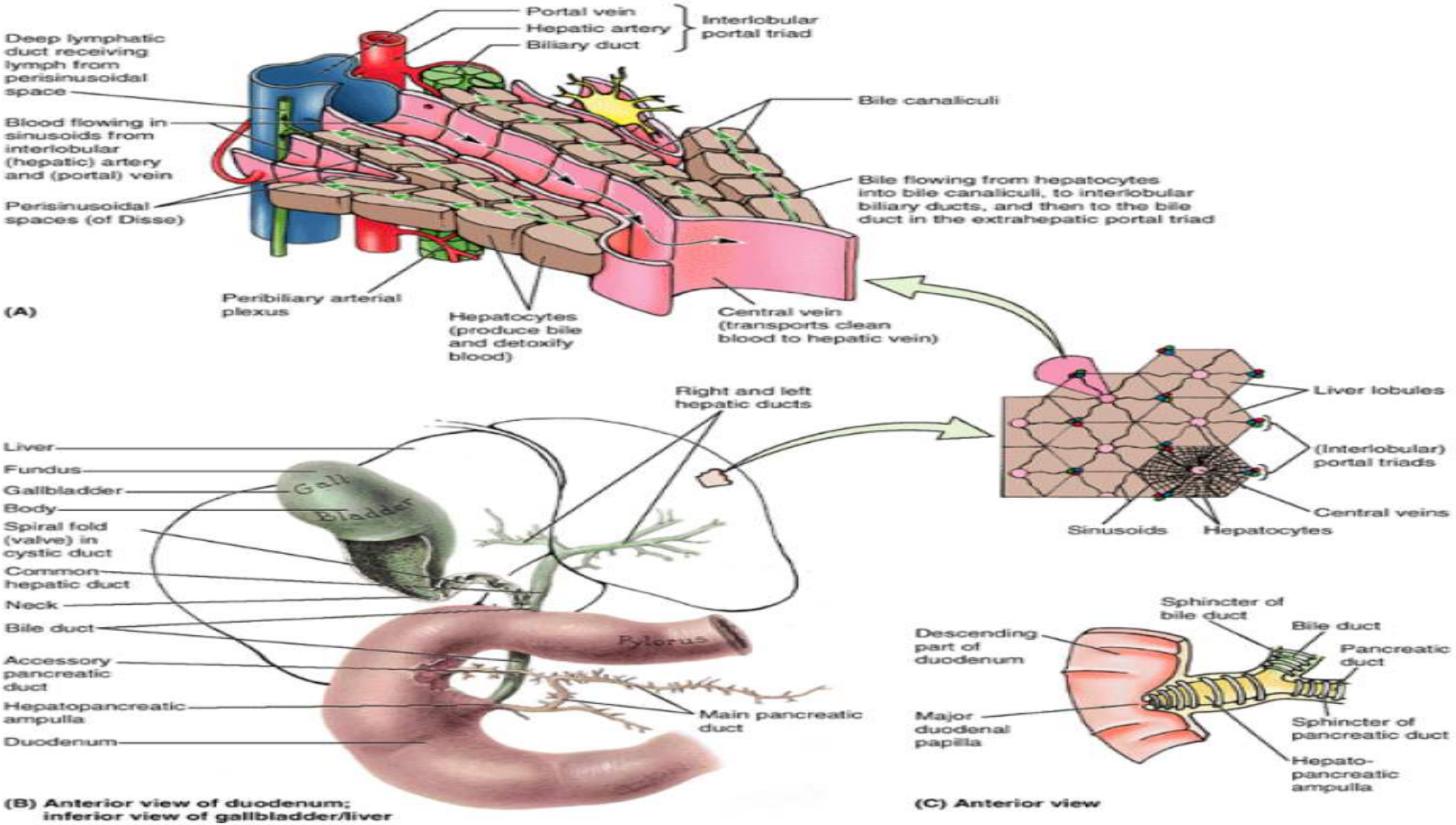
- **Its job is to store and release bile, a fluid made by the liver.**
- **Bile helps break down fats in the food you eat.**
- **Release of bile**
  - **The coordinated release of bile requires simultaneous contraction of the gallbladder and relaxation of the sphincter of Oddi.**
  - **This process is predominantly under humoral control (via cholecystokinin [CCK]), but vagal and splanchnic nerves also play a role**

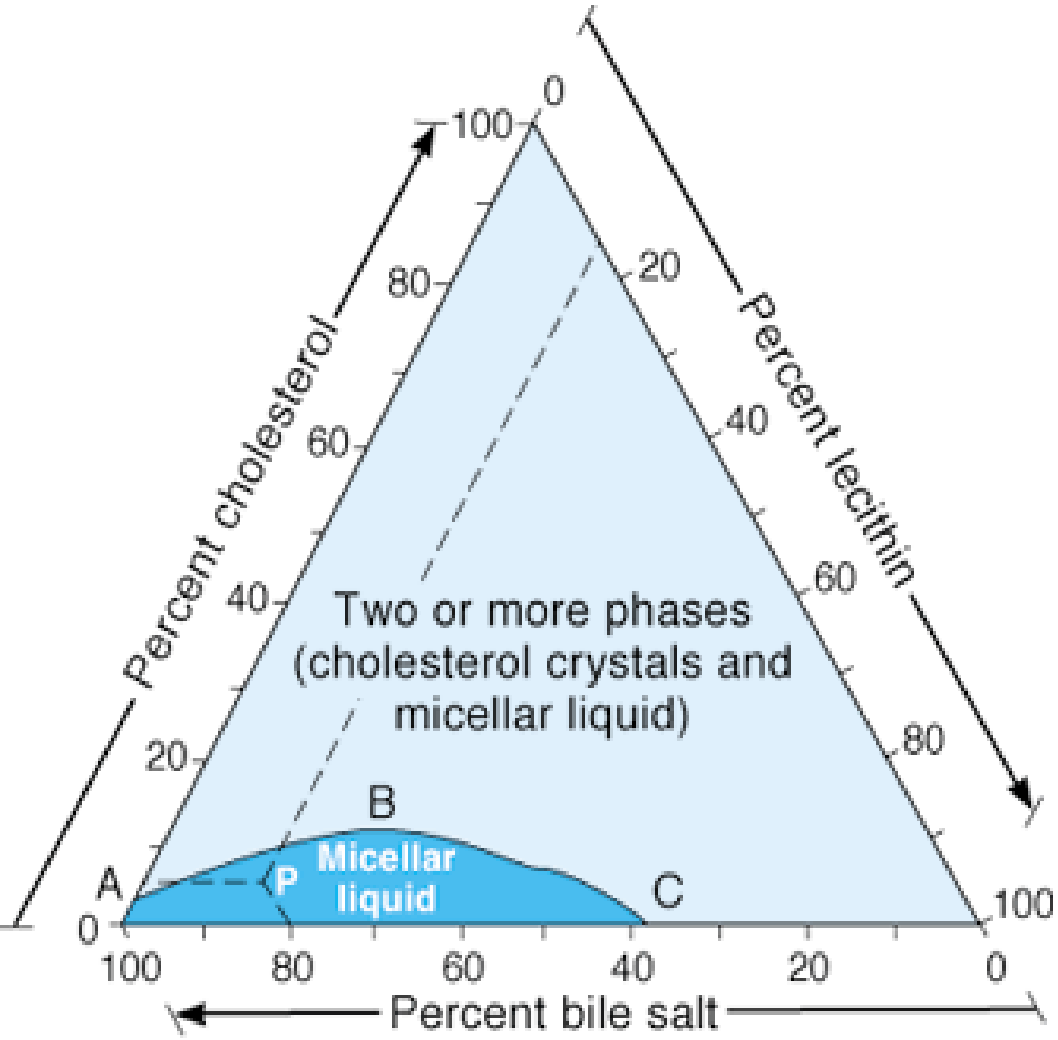
Bile is a physiological aqueous solution produced and secreted by the liver.

It consists mainly of

- **bile salts**
- **phospholipids**
- **cholesterol**
- **conjugated bilirubin,**
- **electrolytes**
- **water**

The hormone secretin also plays an important role in the flow of bile into the small intestine.
By stimulating biliary and pancreatic ductular cells to secrete bicarbonate and water in response to the presence of acid in the duodenum, **secretin effectively expands the volume of bile entering the duodenum**.


Portal vein
Hepatic artery
Biliary duct
Interlobular portal triad
Deep lymphatic duct receiving lymph from perisinusoidal space
Blood flowing in sinusoids from interlobular (hepatic) artery and (portal) vein
Perisinusoidal spaces (of Disse)
Bile canaliculi
Bile flowing from hepatocytes into bile canaliculi, to interlobular biliary ducts, and then to the bile duct in the extrahepatic portal triad
Peribiliary arterial plexus
Hepatocytes (produce bile and detoxify blood)
Central vein (transports clean blood to hepatic vein)
(A)
Liver lobules
(Interlobular) portal triads
Central veins
Sinusoids
Hepatocytes
Right and left hepatic ducts
Liver
Fundus
Gallbladder
Body
Gall Bladder
Spiral fold (valve) in cystic duct
Common hepatic duct
Neck
Bile duct
Accessory pancreatic duct
Hepatopancreatic ampulla
Duodenum
Pylorus
Main pancreatic duct
(B) Anterior view of duodenum; inferior view of gallbladder/liver
Sphincter of bile duct
Bile duct
Pancreatic duct
Descending part of duodenum
Major duodenal papilla
Sphincter of pancreatic duct
Hepato-pancreatic ampulla
(C) Anterior view



Cholesterol solubility in bile as a function of the proportions of lecithin, bile salts, and cholesterol.

In bile that has a composition described by any point below line ABC (eg, point P), cholesterol is solely in micellar solution; points above line ABC describe bile in which there are cholesterol crystals as well. (Reproduced, with permission, from Small DM: Gallstones. N Engl J Med 1968;279:588.)

Bile Secretion

- Necessary for **digestion and absorption of lipids** in small intestine
- Mixture of bile salts, bile pigments, and cholesterol
- Bile salts emulsify lipids to prepare them for digestion
- Solubilize products of lipid digestion in packets called **micelles**
- Bile is produced by **hepatocytes and it is then modified by the cholangiocytes lining the bile ducts.**

- After lipids absorbed, bile salts are recirculated to liver via **enterohepatic circulation**
  - Absorption of bile salts from ileum into portal circulation
  - Delivery back to liver

The main functions of bile are 2-fold:

1.To facilitate lipid absorption and digestion

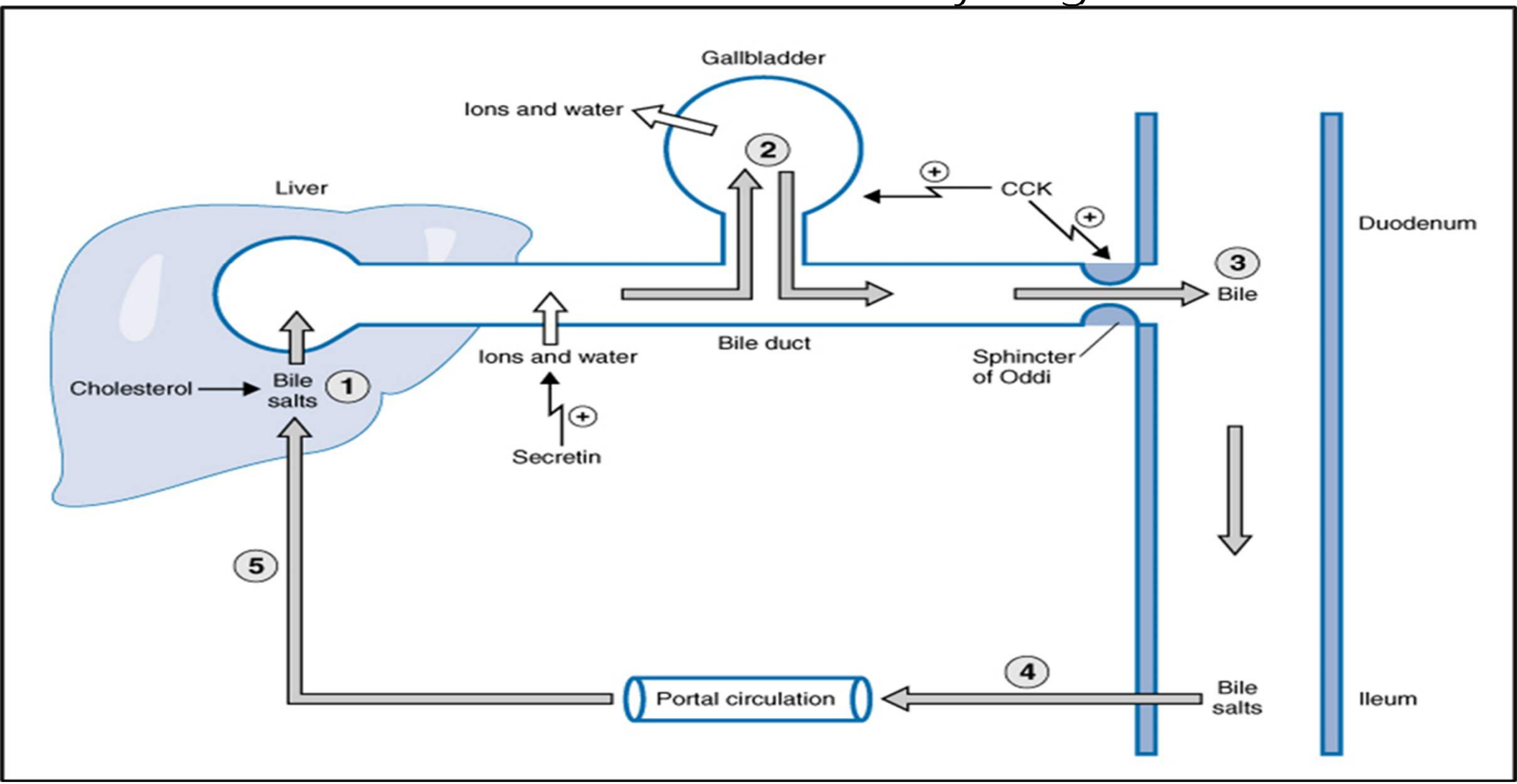
2.To eliminate waste products from the body

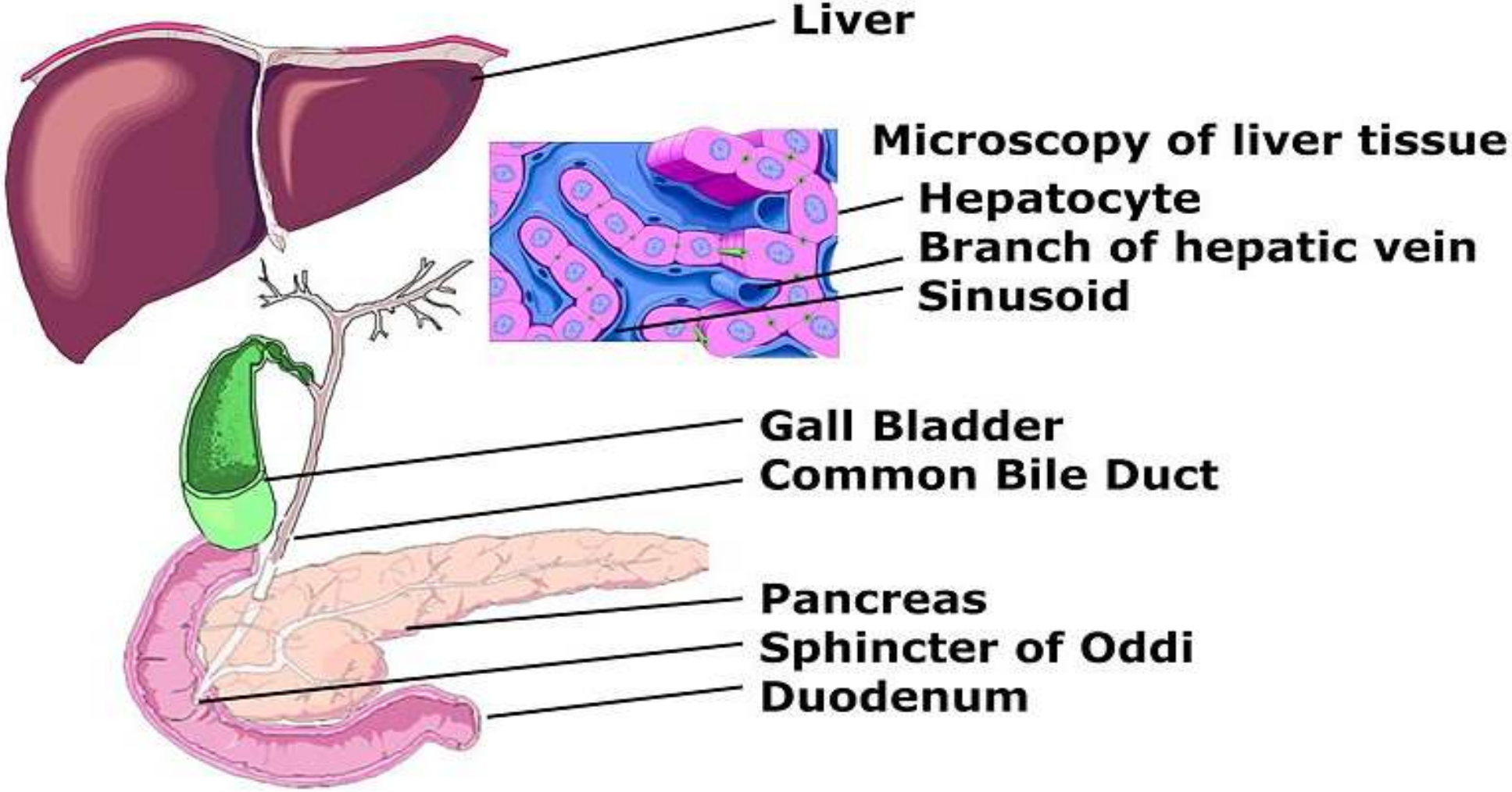
3.Cholesterol is eliminated through its conversion into bile acids, allowing the body to maintain cholesterol homeostasis.

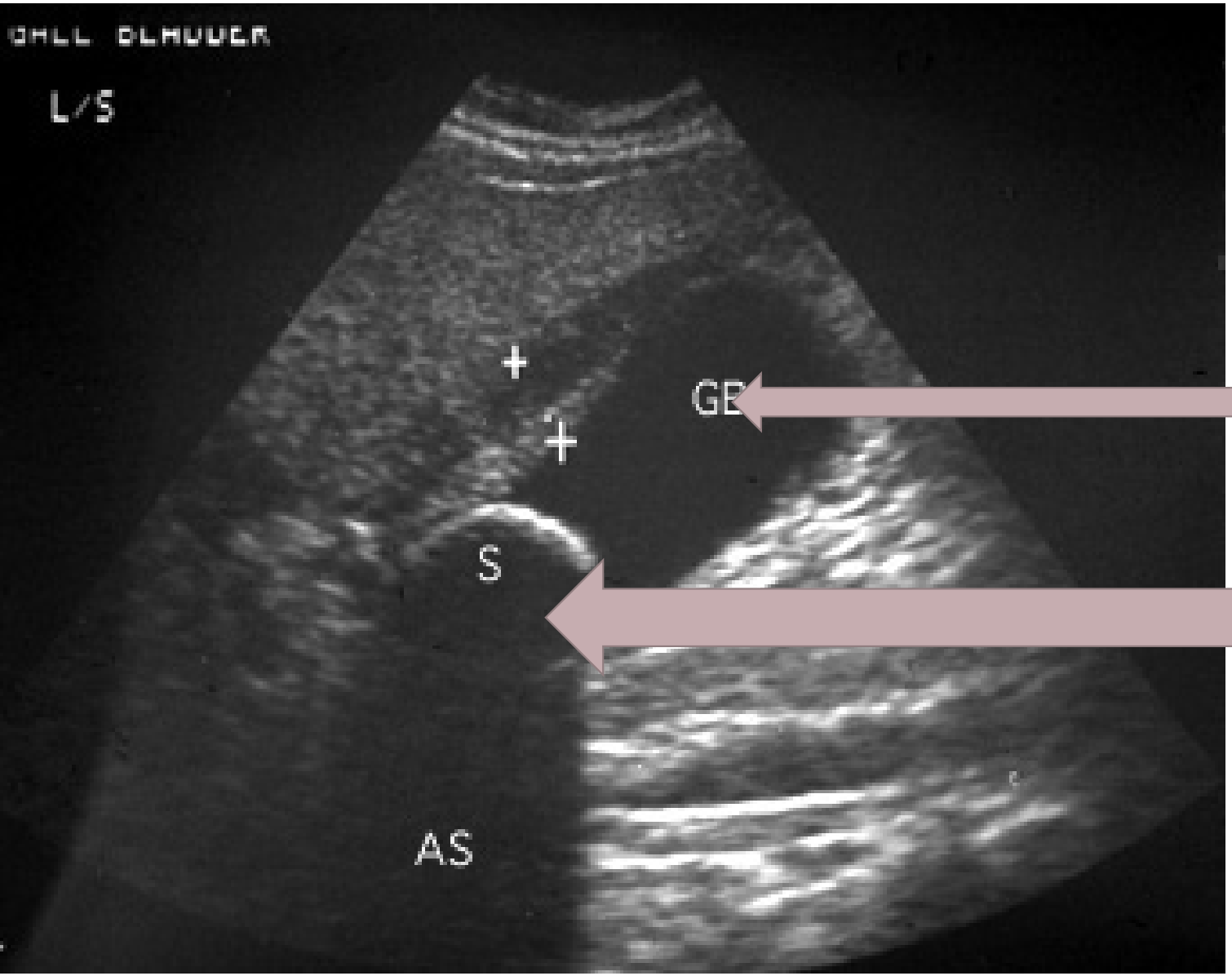
4.Bile acid sequestrants, medications intended to lower cholesterol, function by binding bile acids in the small intestine, and increasing their excretion in the stool.

5.Bilirubin is also eliminated through its secretion into bile, where it eventually forms the dark pigment of feces

Bile Secretion and Recycling




Liver
Microscopy of liver tissue
Hepatocyte
Branch of hepatic vein
Sinusoid
Gall Bladder
Common Bile Duct
Pancreas
Sphincter of Oddi
Duodenum



Gallbladder

Stone
[lithiasis]

Types of Gallstones.			
Type	**Frequency**	**Chemical Composition**	**Gross Appearance**
Mixed	**80%**	**Cholesterol, calcium carbonate, calcium bilirubinate**	**Multiple, small, faceted; variable in size and shape; smooth surface, yellow; laminated on cut section.**
Pure cholesterol	**5%**	**Cholesterol**	**Solitary, large, oval, white; rough surface; cut section: radiating crystalline structure**
Combined	**10%**	**Pure cholesterol center, mixed shell**	**Solitary or 2 stones; oval or barrel–shaped, yellow, smooth surface**
Pigment	**Rare**	**Calcium bilirubinate**	**Multiple, very small, faceted, black**
Calcium	**Very rare**	**Calcium carbonate**	**Multiple, amorphous; small grains, rarely large**

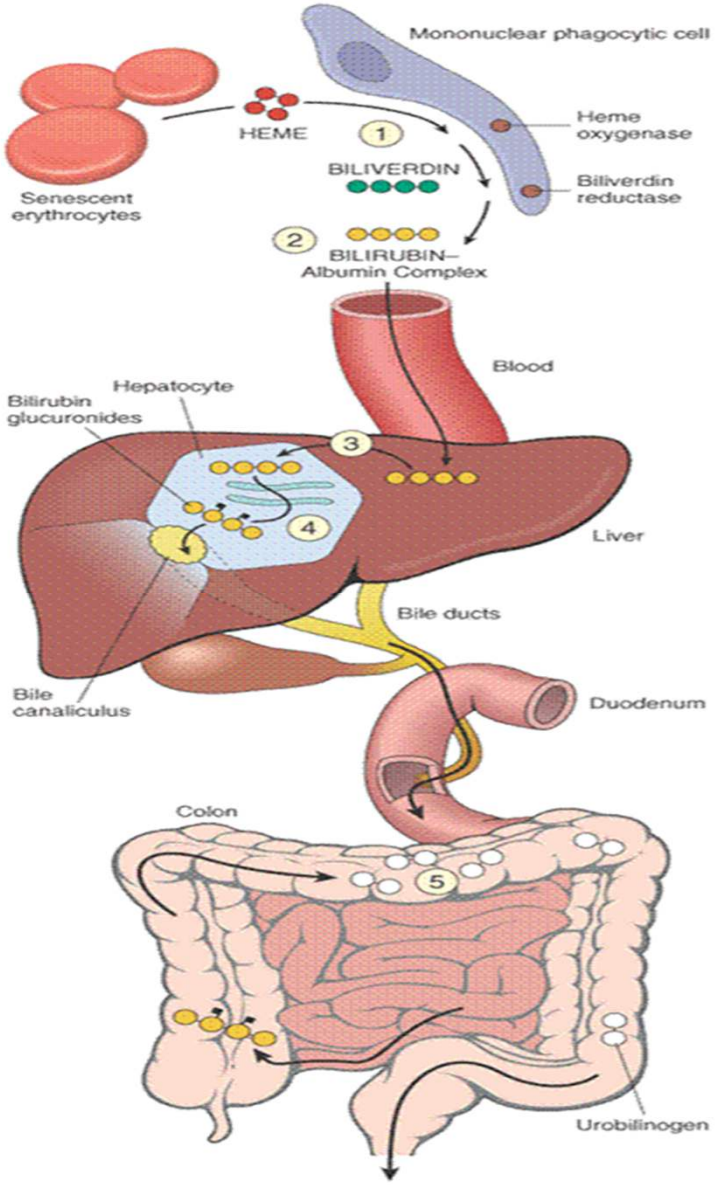

CM 1 2 3 4 5 6 7 8 9 10


11 10 9 8 7 6

Cholesterol stones

- Large
- Often solitary
- Yellow, white or green
- Made primarily of cholesterol (>70%)
- Risk factors:
  - 4 “F” :
    - Female
    - Forty
    - Fertile
    - Fat
  - Fair (5th “F” - more prevalent in Caucasians)
  - Family history (6th “F”)


CM 1 2 3 4

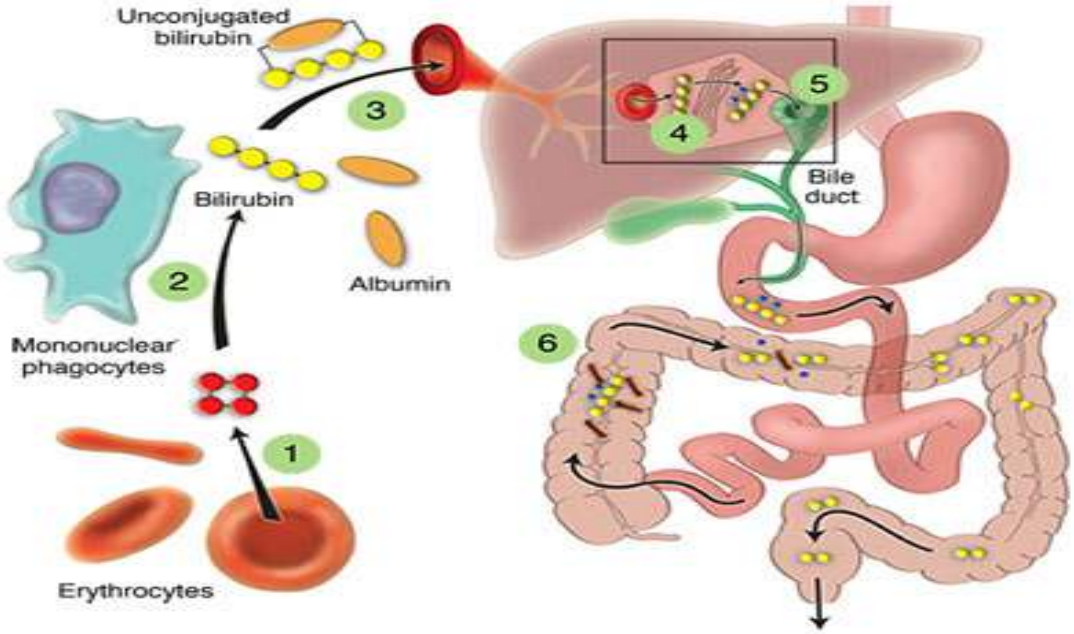


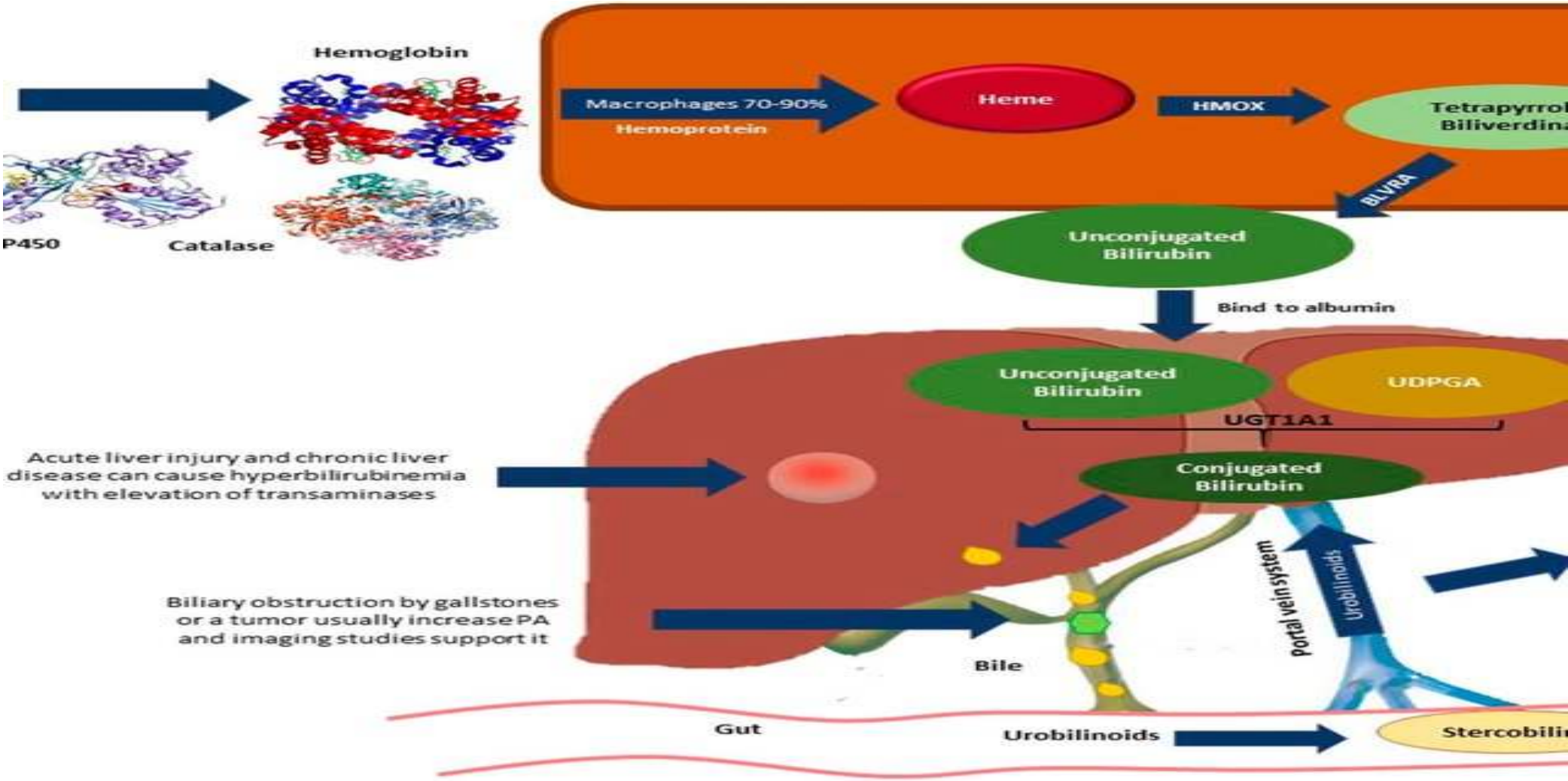
Bilirubin: (0.3-1.2 mg/dl)

UN-conjugated (IN-direct)

Conjugated (direct)

- Bilirubin, the major pigment of bile, is an end product of heme catabolism that travels to the liver bound to albumin.
- The water-soluble conjugated bilirubin is then secreted into bile, providing its characteristic yellow color




Hemoglobin
P450
Catalase
Macrophages 70-90%
Hemoprotein
Heme
HMOX
BLVRA
Unconjugated Bilirubin
Bind to albumin
Unconjugated Bilirubin
UDPGA
UGT1A1
Conjugated Bilirubin
Acute liver injury and chronic liver disease can cause hyperbilirubinemia with elevation of transaminases
Biliary obstruction by gallstones or a tumor usually increase PA and imaging studies support it
Bile
Gut
Urobilinoids
Urobilinoids
portal vein system

Gastrointestinal/Hepatobiliary

Liver: Site of bile formation, reuptake of bile acids, and reuptake of urobilinogen

Bile ducts: Modify and transport bile, secrete ions and water into bile

Gallbladder: Stores and concentrates bile

Small intestine:

- Bacteria form secondary bile acids via dehydroxylation of primary bile acids
- Bilirubin glucuronide is converted back to bilirubin
- Bacteria convert bilirubin to urobilinogen

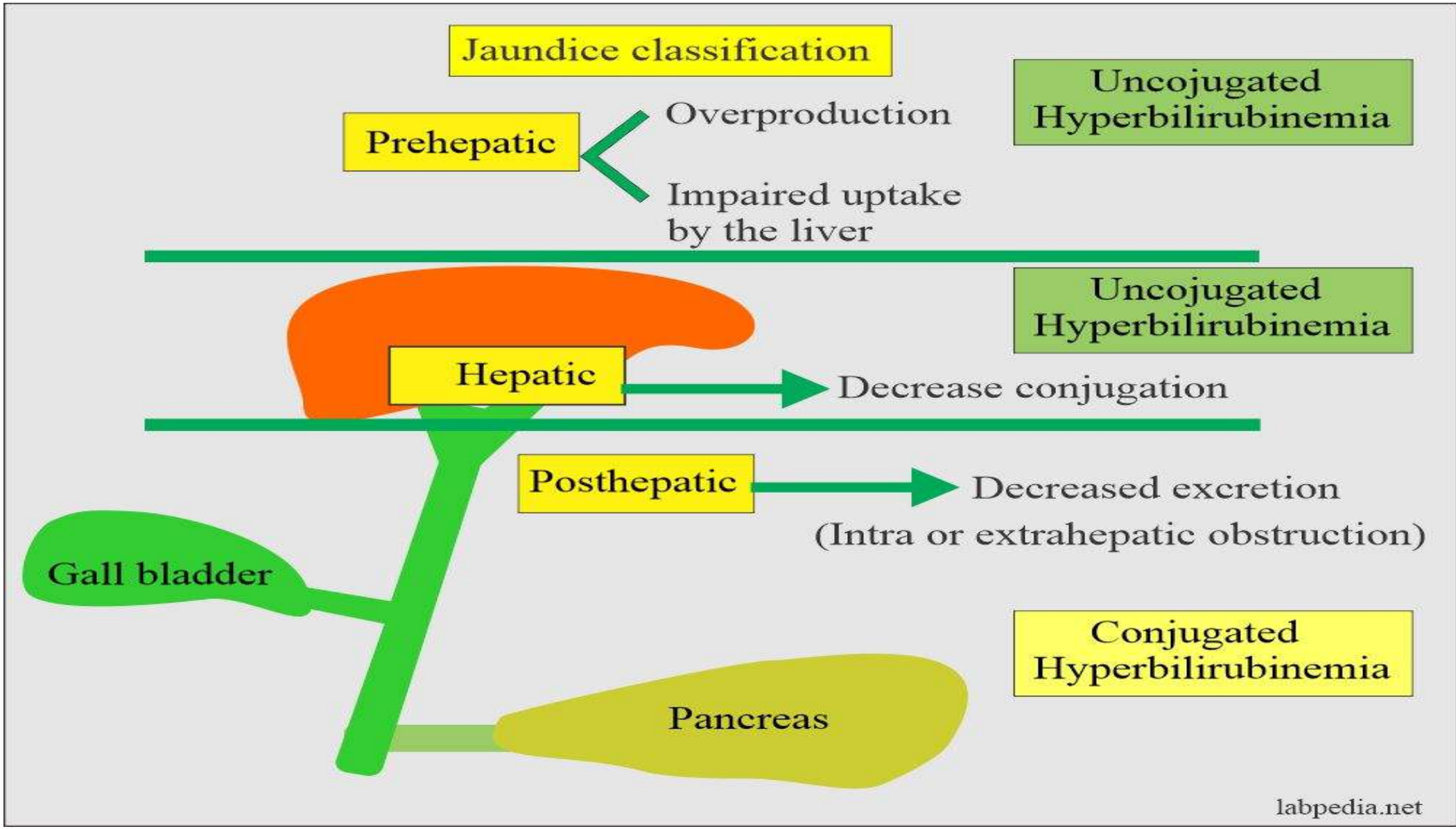
Duodenum: Site of lipid digestion and absorption facilitated by bile

Ileum: Site of reabsorption of bile salts

Portal circulation: Transports reabsorbed bile salts back to the liver

Rectum: Urobilin and stercobilin (compounds oxidized from urobilinogen) are responsible for dark fecal pigment.

- **By FAR, the most common cause of jaundice is choledocholithiasis**


Jaundice classification
Uncojugated Hyperbilirubinemia
Prehepatic
Overproduction
Impaired uptake by the liver
Uncojugated Hyperbilirubinemia
Hepatic
Decrease conjugation
Posthepatic
Decreased excretion
(Intra or extrahepatic obstruction)
Gall bladder
Conjugated Hyperbilirubinemia
Pancreas
labpedia.net

Bilirubine in the urine


Before
phototherapy
After
phototherapy