

Extrahepatic Biliary Apparatus

? Extrahepatic Biliary Apparatus

Introduction

- Collects bile from the liver, stores it in the gallbladder, and transmits it to the **second part of the duodenum**.
- Components:
 1. Right and Left Hepatic Ducts
 2. Common Hepatic Duct
 3. Gallbladder
 4. Cystic Duct
 5. Bile Duct

Right and Left Hepatic Ducts

- Emerge at the **porta hepatis** from respective lobes of the liver.
- **Arrangement of structures at porta hepatis (posterior to anterior):**
 1. Branches of the portal vein

2. Proper hepatic artery

3. Hepatic ducts

Common Hepatic Duct

- Formed by the union of the right and left hepatic ducts near the right end of the **porta hepatis**.
- Descends about **3 cm**, then joins the **cystic duct** to form the **bile duct**.
- **Accessory hepatic ducts** present in ~15% of individuals, usually from right lobe.
 - They may terminate in the gallbladder, common hepatic duct, or upper bile duct.
 - Cause postoperative bile leakage after **cholecystectomy**, so surgical drainage is advised

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Gallbladder

- **Shape:** Pear-shaped reservoir of bile.
- **Location:** Fossa on the **inferior surface of the right lobe of liver**, extending from the right end of the porta hepatis to the inferior border of the liver.
- **Parts:**
 1. **Fundus** – projects beyond inferior liver border, opposite 9th costal cartilage.

2. **Body** – lies in fossa on liver, adherent superiorly to liver (non-peritoneal), peritoneum covers inferior surface related to transverse colon and duodenum.
 3. **Neck** – narrow upper end; continues into cystic duct.
 - **Hartmann's pouch:** mucosal outpouching at posteromedial wall; common site for gallstone lodgment.
 - **Calot's triangle:** bounded by cystic duct (inferiorly), common hepatic duct (medially), and inferior surface of liver (superiorly); contains cystic artery and lymph node of Lund.
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Functions of Gallbladder

1. **Storage of bile** and its release into the duodenum when required.
2. **Absorption of water** and concentration of bile (up to 10×).
3. **Regulation of biliary pressure** by contracting or relaxing in coordination with the sphincter of Oddi.
4. **Pathophysiology:** Disturbance in concentration function ? bile salt absorption ? cholesterol precipitation ? **gallstone formation**

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Applied Anatomy

- **Gallstones (Cholelithiasis):** may lodge in Hartmann's pouch or cystic duct.

- **Cholecystitis:** pain referred to epigastrium, right shoulder, or inferior angle of right scapula (phrenic nerve C3–C5).
- **Accessory ducts:** source of postoperative bile leakage.
- **Cystic artery** – usually from right hepatic artery; variable, so careful dissection required.

Cystic Duct

- **Length:** About **3–4 cm** long and **3 mm** in diameter.
- **Course:** Joins the **common hepatic duct** at an acute angle to form the **bile duct**.
- **Lumen:** Irregular due to **spiral folds of mucosa** called *valves of Heister*, which help maintain the duct's patency and prevent sudden collapse during bile passage.
- **Histology:**
 - Lined by columnar epithelium.
 - Mucosa folded into spiral ridges.
 - Muscular layer continuous with gallbladder musculature.

Bile Duct (Common Bile Duct)

- **Formation:** Union of **common hepatic duct** and **cystic duct**.

- **Length:** About **8 cm**.

- **Parts and Course:**

1. **Supraduodenal Part** – lies in the free margin of the lesser omentum.
 - *Anteriorly:* Liver
 - *Posteriorly:* Portal vein, epiploic foramen
 - *Left side:* Hepatic artery
2. **Retroduodenal Part** – behind the first part of the duodenum.
 - *Anteriorly:* Duodenum
 - *Posteriorly:* Inferior vena cava
 - *Left:* Gastroduodenal artery
3. **Infraduodenal Part** – embedded in a groove on the posterior surface of the head of the pancreas.
4. **Intraduodenal Part** – oblique course through the duodenal wall; unites with pancreatic duct to form the **hepatopancreatic ampulla (of Vater)**.
 - Opens at the **major duodenal papilla**, 8–10 cm distal to the pylorus.

Sphincters Related to the Bile and Pancreatic Ducts

1. **Sphincter Choledochus (of Boyden):**

- Surrounds terminal part of the bile duct above the junction with pancreatic duct.
- Always present; keeps bile duct closed when gallbladder fills.
- Opens during fatty meal intake under hormonal influence (cholecystokinin).

2. **Sphincter Pancreaticus:**

- Surrounds terminal part of the pancreatic duct; variably developed.

3. **Sphincter Ampullae (of Oddi):**

- Surrounds hepatopancreatic ampulla; regulates bile and pancreatic juice flow into the duodenum.
- Coordinates with gallbladder contraction and relaxation of sphincter choledochus.

Vascular and Nerve Supply

Arterial Supply

1. **Cystic artery** (chief source) — branch of right hepatic artery; supplies gallbladder, cystic duct, hepatic ducts, and upper bile duct.
2. **Posterior superior pancreaticoduodenal artery** — supplies lower bile duct.
3. **Right hepatic artery** — minor supply to mid-portion of bile duct.

Venous Drainage

1. **Superior surface of gallbladder** ? veins drain directly into liver.

2. **Rest of gallbladder** ? cystic veins ? right branch of portal vein.
3. **Lower bile duct** ? drains directly into portal vein.

Lymphatic Drainage

- **Upper part (gallbladder, cystic duct, hepatic ducts):**
? *Cystic node* (in Calot's triangle) ? *upper hepatic nodes* (on anterior border of epiploic foramen).
- **Lower bile duct:**
? *Lower hepatic nodes* ? *pancreaticosplenic nodes*.

Nerve Supply

- **Sympathetic:** From *coeliac plexus* ? pain and vasomotor control.
- **Parasympathetic:** From *vagus nerve* ? motor to gallbladder and relaxation of sphincters.
- **Sensory (referred pain):** via *phrenic nerve* (C3–C5) ? pain referred to right shoulder and inferior angle of right scapula.

Clinical Anatomy

1. **Biliary Obstruction:**
 - Blockage of bile flow due to gallstones or carcinoma of pancreas.
 - Results in **obstructive jaundice**: pale stools, dark urine, yellow sclera, and pruritus.

2. **Cholelithiasis (Gallstones):**

- Formed by cholesterol or pigment stones due to bile stasis or infection.
- Lodgement in cystic duct ? colicky pain, vomiting, and cholecystitis.

3. **Cholecystitis:**

- Inflammation of gallbladder; pain referred to **epigastrium, right shoulder, or inferior angle of right scapula.**

4. **Calot's Triangle (Cystohepatic Triangle):**

- *Boundaries:*
 - Inferior ? Cystic duct
 - Medial ? Common hepatic duct
 - Superior ? Inferior surface of liver
- *Contents:* Cystic artery and cystic lymph node.
- *Importance:* Landmark during **cholecystectomy.**

5. **Biliary Investigation Techniques:**

- **Ultrasound** – to detect gallstones.
- **ERCP (Endoscopic Retrograde Cholangiopancreatography)** – to visualize bile and pancreatic ducts.

6. **Hormonal Control:**

- **Cholecystokinin-pancreozymin (CCK-PZ)** released from duodenal mucosa ? contracts gallbladder and relaxes sphincters.

7. Referred Pain:

- Stretching of bile duct or gallbladder ? pain in **epigastrium** and **right shoulder** (due to diaphragmatic peritoneal innervation).

? Histology of Gallbladder

The gallbladder wall has **three main layers** (no submucosa and no muscularis mucosae).

1. Mucosa

- Lined by **simple columnar epithelium** with tall absorptive cells containing **microvilli**.
- Epithelium rests on a **lamina propria** made of loose connective tissue rich in capillaries.
- The mucosa shows **numerous folds and ridges**, forming a honeycomb pattern when contracted.
- **Rokitansky–Aschoff sinuses**: Small mucosal outpouchings that extend into the muscular layer; often seen in chronic cholecystitis.
- Function: Absorbs water and electrolytes to **concentrate bile**.

2. Muscular Layer

- Composed of **irregularly arranged bundles** of smooth muscle fibers (no distinct circular or longitudinal orientation).
- Contraction is controlled by **cholecystokinin (CCK)**, causing expulsion of bile.

3. Adventitia and Serosa

- **Superior (hepatic) surface:** Non-peritoneal; attached to liver by areolar tissue (adventitia).
 - **Inferior surface:** Covered by peritoneum (serosa).
 - Contains blood vessels, lymphatics, and autonomic nerves.
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? Functional Features

- **Absorptive function:** Active sodium and water absorption concentrate bile up to 10 times.
 - **Mucus secretion:** Protects mucosa from concentrated bile acids.
 - **Storage:** 30–60 mL bile reservoir under fasting conditions.
 - **Response to meals:** Gallbladder contracts due to *CCK-PZ*, while sphincter of Oddi relaxes, allowing bile flow into duodenum.
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? Development of Extrahepatic Biliary Apparatus

Embryological Origin

- Derived from the **hepatic diverticulum** — an endodermal outgrowth from the **caudal part of the foregut** (4th week).

1. Hepatic Diverticulum:

- Grows into **ventral mesentery** toward the septum transversum.
- Divides into two parts:
 - **Pars hepatica (cranial part):** Forms liver parenchyma and hepatic ducts.
 - **Pars cystica (caudal part):** Forms gallbladder and cystic duct.

2. Common Hepatic Duct:

- Formed from the **stalk** of the hepatic diverticulum.

3. Bile Duct:

- Initially a common channel from hepatic diverticulum to duodenum.
- Later, rotation of duodenum moves the opening dorsally, placing the bile duct **posterior to the first part of duodenum** and in contact with the **pancreatic duct**.

Epithelial and Mesodermal Contributions

- **Epithelium:** Derived from endoderm of foregut.
- **Connective tissue and muscle:** Derived from **splanchnic mesoderm**.

Developmental Anomalies

1. **Agenesis of Gallbladder:** Complete absence; rare.
2. **Double Gallbladder:** Two sacs, often with separate cystic ducts.
3. **Accessory Hepatic Ducts:** May open into gallbladder or bile duct — important surgically.

4. **Abnormal Termination of Bile Duct:** May open into duodenum separately from pancreatic duct.
 5. **Atresia or Stenosis:** Failure of recanalization of biliary ducts ? neonatal **obstructive jaundice**.
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? Clinical Insight

- **Embryological correlation:** Persistence of fetal solid phase of ducts may lead to **biliary atresia** (infantile jaundice).
- **Surgical note:** Awareness of variations in cystic duct or accessory ducts prevents bile leakage after cholecystectomy.
- **Functional correlation:** Hormone *CCK-PZ* (from duodenal mucosa) coordinates bile expulsion during digestion of fats.

? Facts to Remember

- The **gallbladder** both stores and concentrates bile; this concentration predisposes to **gallstone formation (cholelithiasis)**.
- The **cystic artery** commonly arises from the **right hepatic artery**, but its origin and relation to the bile ducts are **highly variable**—this is vital knowledge during **cholecystectomy**.
- **Pain of cholecystitis** is often referred to the **epigastrium, right shoulder, or inferior angle of the right scapula**, due to the **phrenic nerve (C3–C5)** innervation.

- **Murphy's sign:** Tenderness and arrest of inspiration when palpating under the right costal margin (indicates cholecystitis).
- **Courvoisier's law:** Distended, palpable gallbladder with jaundice suggests **malignant obstruction** (e.g., carcinoma of head of pancreas), not stones.
- **Referred pain** from gallbladder or bile duct is mediated via the **right phrenic nerve**, hence perceived in the **supraclavicular region**.
- The **Calot's triangle** is bounded by:
 - Cystic duct (inferiorly)
 - Common hepatic duct (medially)
 - Inferior surface of liver (superiorly)
 It contains the **cystic artery** and **cystic lymph node (Lund's node)**.
- **ERCP (Endoscopic Retrograde Cholangiopancreatography)** is used to visualize and assess bile duct patency.
- **Gallstones** may erode through the gallbladder wall into the **duodenum**, causing intestinal obstruction at the **ileocaecal junction** (*gallstone ileus*).
- **Cholecystikinin-pancreozymin (CCK-PZ)**, secreted from the duodenum after fatty meals, causes gallbladder contraction and sphincter relaxation.
- **Typhoid bacilli** can persist in the gallbladder, producing a chronic carrier state.

? Clinicoanatomical Problems

Case 1

A **fat, fair, fertile, forty-year-old female** complains of spasmodic pain in the **right hypochondrium**, radiating to the **epigastrium** and **right shoulder**.

Questions & Explanations:

- **Cause of pain:** Gallstones obstructing the cystic duct ? distension of gallbladder (cholelithiasis).
 - **Radiation:** Referred via *phrenic nerve* to epigastrium and right shoulder.
 - **Murphy's sign:** Pain and inspiratory arrest when pressing below the right costal margin—positive in acute cholecystitis.
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Case 2

During open **cholecystectomy**, the surgeon encounters severe bleeding.

Questions & Explanations:

- **Bleeding source:** Usually the **cystic artery**.
 - **Control:** Can compress **proper hepatic artery** (in anterior wall of epiploic foramen) between thumb and finger.
 - **Alternate procedure:** **Laparoscopic cholecystectomy** is now standard.
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Case 3

A patient with **jaundice and distended gallbladder**.

Interpretation:

- Suggests **malignant obstruction** (e.g., carcinoma of the head of pancreas).

- Follows **Courvoisier's law** — extrinsic obstruction causes dilatation, intrinsic (stone) does not.
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Case 4

A patient develops **intestinal obstruction** due to a gallstone.

Explanation:

- Gallstone erodes through gallbladder into **duodenum**, travels through small intestine, and lodges at **ileocaecal junction** ? *gallstone ileus*.
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Case 5

Postoperative bile leakage after cholecystectomy.

Cause:

- Unrecognized **accessory hepatic duct** injured during surgery.
- Solution: Adequate drainage to prevent bile peritonitis.

? Clinicoanatomical Problems (Extended Set)

Case 6 – Acute Cholecystitis

A 45-year-old woman presents with **fever, vomiting, and severe right hypochondrial pain** radiating to the right shoulder. Pain worsens after fatty meals.

Explanation:

- Inflammation of the **gallbladder** due to cystic duct obstruction by gallstone.

- **Referred pain:** via right **phrenic nerve (C3–C5)** to right shoulder.
 - **Murphy's sign:** Positive.
 - **Anatomical basis:** Gallbladder in contact with visceral surface of liver ? inflammation may spread to hepatic capsule causing localized peritonitis.
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Case 7 – Choledocholithiasis

A patient develops **obstructive jaundice** with clay-colored stool and dark urine.

Explanation:

- **Gallstone** lodged in the **common bile duct (CBD)**.
 - **Anatomical effect:** Bile cannot enter duodenum ? bilirubin regurgitates into blood.
 - **Key site:** Distal CBD near hepatopancreatic ampulla.
 - **Investigation:** ERCP or MRCP imaging.
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Case 8 – Carcinoma of Head of Pancreas

A 60-year-old male presents with **progressive jaundice, pale stool, and weight loss**, but **no pain**.

Explanation:

- Tumor compresses the **intrapancreatic part of the bile duct**, obstructing bile flow.
 - **Courvoisier's sign:** Painless, palpable gallbladder due to extrinsic obstruction.
 - **Referred pain:** May appear in the back due to pancreatic involvement.
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Case 9 – Cholangitis

A 52-year-old woman with gallstones develops **fever with chills, jaundice, and right upper quadrant pain** (Charcot's triad).

Explanation:

- Infection and inflammation of the **bile duct** (ascending cholangitis).
 - **Pathway:** Gallstone obstructs CBD ? bacterial infection from duodenum.
 - **Complication:** Sepsis, hepatic abscess.
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Case 10 – Biliary Atresia in a Newborn

A 3-week-old baby presents with **persistent jaundice** and **pale stools** since birth.

Explanation:

- Failure of **recanalization of bile ducts** (developmental anomaly).
 - **Consequence:** Bile accumulation ? hepatomegaly and neonatal cholestasis.
 - **Treatment:** Surgical (Kasai portoenterostomy).
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Case 11 – Biliary Fistula

Following open cholecystectomy, a patient shows **persistent bile drainage** from the wound.

Explanation:

- Accidental injury to an **accessory hepatic duct** or **cystic duct stump leak**.
 - **Anatomical note:** Accessory ducts commonly arise from the right lobe and open into the gallbladder or hepatic ducts.
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Case 12 – Mirizzi Syndrome

A gallstone lodged in the **cystic duct** compresses the **common hepatic duct**, leading to **jaundice** without CBD stones.

Explanation:

- Due to close proximity between cystic and common hepatic ducts.
 - May cause **fistula formation** between the two ducts.
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Case 13 – Sphincter of Oddi Dysfunction

A patient develops **biliary colic** and **transient jaundice** after fatty meals.

Explanation:

- **Spasm or fibrosis** of the sphincter of Oddi prevents bile flow.
 - **Effect:** Back pressure ? gallbladder distension and pain.
 - **Hormonal link:** Lack of proper response to **cholecystokinin**.
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Case 14 – Gallstone Ileus

An elderly woman develops **intestinal obstruction** after long-standing gallstones.

Explanation:

- Stone erodes through gallbladder wall ? enters duodenum ? lodges at **ileocaecal junction**.
 - **Anatomical sequence:** Gallbladder ? duodenum ? small intestine ? obstruction.
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Case 15 – Biliary Peritonitis

A post-traumatic patient develops **acute peritonitis with bile-stained fluid** in the abdomen.

Explanation:

- Rupture of **gallbladder** or **bile duct** leads to leakage into peritoneal cavity.
 - **Consequence:** Chemical peritonitis due to bile salts.
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Case 16 – Post-Cholecystectomy Syndrome

After gallbladder removal, patient complains of **right upper abdominal pain and dyspepsia**.

Explanation:

- Residual **stone in CBD** or **sphincter spasm** of Oddi.
 - **Clinical note:** Need imaging (ERCP) to identify retained stones.
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Case 17 – Cystic Artery Injury

During laparoscopic cholecystectomy, sudden **bleeding obscures the surgical field**.

Explanation:

- **Cystic artery** runs in **Calot's triangle**, and variations are common.
 - **Preventive step:** Always identify cystic artery before clipping.
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Case 18 – Referred Pain in Cholelithiasis

Pain radiating from right hypochondrium to **inferior angle of right scapula**.

Explanation:

- Due to irritation of **diaphragmatic peritoneum**, supplied by the **phrenic nerve** (C3–C5).
 - Sensory fibers refer pain to C4 dermatome (shoulder region).
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Case 19 – Empyema of Gallbladder

Patient develops **severe fever, leukocytosis, and tense palpable gallbladder.**

Explanation:

- Suppurative infection of the gallbladder due to cystic duct obstruction.
- **Complication:** Gangrene or perforation.

Case 20 – Biliary Colic

Sudden severe pain in right hypochondrium radiating to **right shoulder**, often after a fatty meal.

Explanation:

- Spasm of the **smooth muscle of the gallbladder wall** or **bile duct** due to transient obstruction by stone.
- **Duration:** Usually short-lived (<6 hours).

? Frequently Asked Questions – Extrahepatic Biliary Apparatus

1. What are the components of the extrahepatic biliary apparatus?

The extrahepatic biliary apparatus consists of:

- Right and left hepatic ducts
- Common hepatic duct
- Cystic duct

- Gallbladder
 - Bile duct (common bile duct)
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2. What is the function of the gallbladder?

- Stores and concentrates bile.
 - Contracts during digestion (especially after fatty meals) under the action of **cholecystokin (CCK)** to release bile into the duodenum.
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3. What are the parts of the bile duct?

1. Supraduodenal
 2. Retroduodenal
 3. Infraduodenal (within the pancreatic groove)
 4. Intraduodenal (within the wall of duodenum)
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4. What is the sphincter of Oddi?

- A muscular sphincter surrounding the **ampulla of Vater** (terminal part of bile and pancreatic ducts).
 - Regulates bile and pancreatic juice flow into the duodenum.
 - Relaxes under the influence of **CCK-PZ**.
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5. What structures form the hepatopancreatic ampulla?

The **common bile duct** and the **main pancreatic duct (duct of Wirsung)** unite to form the **ampulla of Vater**, which opens at the **major duodenal papilla**.

6. What is Calot's triangle (cystohepatic triangle)?

Boundaries:

- Inferior ? Cystic duct
- Medial ? Common hepatic duct
- Superior ? Inferior surface of the liver

Contents: Cystic artery and cystic lymph node (of Lund).

Surgical importance: Landmark during cholecystectomy.

7. What is Hartmann's pouch?

- A small diverticulum of the gallbladder neck where gallstones commonly lodge.
 - Situated between the neck of gallbladder and cystic duct.
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8. What is Courvoisier's law?

- In the presence of **jaundice and a palpable gallbladder**, the cause is **malignant obstruction** (e.g., carcinoma of the head of pancreas), not gallstones.
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9. What is Murphy's sign?

- Elicited by pressing under the right costal margin during inspiration.
 - Arrest of inspiration due to pain indicates **acute cholecystitis**.
-

10. What is the arterial supply of the gallbladder?

- Chiefly from the **cystic artery**, a branch of the **right hepatic artery**.
 - Lies within Calot's triangle.
 - The lower bile duct receives blood from the **posterior superior pancreaticoduodenal artery**.
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11. How is the gallbladder drained venously?

- Upper surface ? directly into liver substance.
 - Lower surface ? via cystic veins into portal vein.
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12. What are the lymphatic drainage pathways of the gallbladder?

- **Cystic lymph node (Lund's node)** ? **hepatic nodes** ? **celiac nodes**.
-

13. What is the nerve supply of the gallbladder and bile duct?

- **Sympathetic fibers:** from celiac plexus (pain sensation).
 - **Parasympathetic fibers:** from vagus nerve (motor to gallbladder, relax sphincters).
 - **Sensory fibers:** via phrenic nerve ? referred pain to right shoulder and scapular region.
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14. What are the functions of bile?

- Emulsification of fats.
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- Neutralization of gastric acid in the duodenum.
 - Excretion of bilirubin and cholesterol.
 - Aids in absorption of fat-soluble vitamins (A, D, E, K).
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15. What are Rokitansky–Aschoff sinuses?

- Small mucosal diverticula that extend into the muscular wall of the gallbladder.
 - Commonly seen in **chronic cholecystitis**.
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16. What is the developmental origin of the gallbladder and bile ducts?

- Derived from the **pars cystica** of the **hepatic diverticulum** (endodermal outgrowth from the foregut).
 - Muscles and connective tissue from **splanchnic mesoderm**.
-

17. What are the common developmental anomalies of the biliary apparatus?

- Agenesis or duplication of gallbladder.
 - Accessory hepatic ducts.
 - Abnormal termination of bile duct.
 - Atresia or stenosis (failure of recanalization).
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18. What is biliary atresia?

- Congenital absence or obliteration of bile ducts due to failure of recanalization.
 - Leads to neonatal jaundice and cholestasis.
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19. What are the common causes of obstructive jaundice?

- Gallstones in the bile duct (choledocholithiasis).
 - Carcinoma of the head of pancreas.
 - Stricture or atresia of bile ducts.
 - Parasite infestation (Clonorchis sinensis).
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20. What is the normal anatomical relationship of the bile duct to the duodenum and pancreas?

- Lies **posterior to the first part of duodenum**, then passes **through the head of pancreas** to open into the **second part of duodenum** at the **major duodenal papilla**.

? Multiple Choice Questions – Extrahepatic Biliary Apparatus

1. The **cystic artery** is a branch of:

- a. Right hepatic artery
- b. Left hepatic artery
- c. Coeliac trunk
- d. Common hepatic artery

? **Answer:** a. Right hepatic artery

2. The **capacity of the gallbladder** is approximately:

- a. 50–150 mL
- b. 30–60 mL
- c. 150–300 mL
- d. 350–500 mL

? **Answer:** b. 30–60 mL

3. The **cystic duct** joins which of the following ducts?

- a. Common hepatic duct
- b. Right hepatic duct
- c. Left hepatic duct
- d. None of these

? **Answer:** a. Common hepatic duct

4. Pain of gallstones is referred to all the following areas **except**:

- a. Tip of right shoulder
- b. Epigastric region
- c. Inferior angle of left scapula
- d. Inferior angle of right scapula

? **Answer:** c. Inferior angle of left scapula

5. Which of the following structures lies within **Calot's triangle**?

- a. Portal vein
- b. Cystic artery
- c. Right hepatic vein
- d. Inferior vena cava

? **Answer:** b. Cystic artery

6. The **sphincter of Oddi** surrounds which structure?

- a. Cystic duct
- b. Hepatopancreatic ampulla
- c. Common hepatic duct
- d. Gallbladder neck

? **Answer:** b. Hepatopancreatic ampulla

7. Hartmann's pouch is found in which part of the gallbladder?

- a. Fundus
- b. Body
- c. Neck
- d. None

? **Answer:** c. Neck

8. The gallbladder develops from:

- a. Pars hepatica
- b. Pars cystica
- c. Hepatic bud
- d. Ventral pancreas

? **Answer:** b. Pars cystica

9. Referred pain from the gallbladder is carried by which nerve?

- a. Intercostal
- b. Phrenic
- c. Vagus
- d. Sympathetic from celiac plexus

? **Answer:** b. Phrenic nerve

10. The common bile duct opens into the duodenum at the:

- a. Minor duodenal papilla
- b. Major duodenal papilla
- c. Foramen of Winslow
- d. Ampulla of Vater

? **Answer:** b. Major duodenal papilla

? **Answer Key Summary**

- 1 – a
- 2 – b
- 3 – a
- 4 – c

- 5 – b
- 6 – b
- 7 – c
- 8 – b
- 9 – b
- 10 – b

? Viva Voce – Extrahepatic Biliary Apparatus

1. What are the components of the extrahepatic biliary apparatus?

Right and left hepatic ducts, common hepatic duct, cystic duct, gallbladder, and common bile duct.

2. What is the function of the gallbladder?

It stores and concentrates bile and expels it into the duodenum when required for fat digestion.

3. What is the capacity of the gallbladder?

Approximately **30–60 mL**.

4. What is the location of the fundus of the gallbladder?

At the tip of the **ninth costal cartilage**, where it meets the **right lateral border of the rectus abdominis**.

5. What is Calot's triangle?

Boundaries:

- Inferiorly – cystic duct

- Medially – common hepatic duct
 - Superiorly – inferior surface of the liver
Contents: cystic artery and cystic lymph node (of Lund).
-

6. What is Hartmann's pouch?

A small diverticulum at the **neck of the gallbladder** where gallstones commonly lodge.

7. What are the four parts of the bile duct?

Supraduodenal, retroduodenal, infraduodenal (in pancreatic groove), and intraduodenal parts.

8. Where does the common bile duct open?

At the **major duodenal papilla** in the **second part of the duodenum**.

9. What is the hepatopancreatic ampulla?

A dilation formed by the union of the **common bile duct** and **main pancreatic duct**, guarded by the **sphincter of Oddi**.

10. What are the sphincters associated with the bile passage?

1. **Sphincter choledochus (Boyden)** – surrounds terminal bile duct.
 2. **Sphincter pancreaticus** – around pancreatic duct.
 3. **Sphincter ampullae (Oddi)** – around hepatopancreatic ampulla.
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11. What is the nerve supply of the gallbladder?

- Sympathetic: from celiac plexus
-

- Parasympathetic: from vagus nerve
 - Sensory: via right phrenic nerve (causing referred pain to right shoulder/scapula)
-

12. What is the arterial supply of the gallbladder?

By the **cystic artery**, a branch of the **right hepatic artery**.

13. What is Courvoisier's law?

A **distended, palpable gallbladder** with jaundice suggests **malignant obstruction** (e.g., carcinoma of head of pancreas) rather than stones.

14. What is Murphy's sign?

On deep inspiration, pressing under the right costal margin causes sharp pain and inspiratory arrest — a sign of **acute cholecystitis**.

15. What is the developmental origin of the gallbladder and cystic duct?

From the **pars cystica** of the hepatic diverticulum (endodermal outgrowth from foregut).

16. What is biliary atresia?

Congenital failure of recanalization of bile ducts, leading to **neonatal obstructive jaundice**.

17. What hormone controls gallbladder contraction?

Cholecystokinin-pancreozymin (CCK-PZ) released from duodenal mucosa after fatty meals.

18. What are Rokitansky–Aschoff sinuses?

Mucosal diverticula that extend into the muscular layer of the gallbladder, seen in **chronic cholecystitis**.

19. What is the surgical importance of the cystic artery?

It must be carefully identified and ligated within **Calot's triangle** during **cholecystectomy** to prevent hemorrhage.

20. What is the clinical importance of the phrenic nerve in gallbladder disease?

Pain from gallbladder inflammation is referred to the **right shoulder** and **inferior angle of right scapula** through **phrenic nerve fibers (C3–C5)**.

21. What is the function of bile?

- Emulsification of fats
 - Aids in absorption of fat-soluble vitamins (A, D, E, K)
 - Neutralizes gastric acid
 - Excretes cholesterol and bilirubin
-

22. What is cholelithiasis?

Formation of **gallstones** due to imbalance between bile salts, cholesterol, and phospholipids, often in **fat, fair, fertile, forty females**.

23. What is the relation of the gallbladder to the peritoneum?

- Superior surface: non-peritoneal, attached to liver.
 - Inferior surface: covered by peritoneum related to duodenum and transverse colon.
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24. Which artery supplies the lower part of the bile duct?

Posterior superior pancreaticoduodenal artery.

25. What is cholecystectomy?

Surgical removal of the gallbladder; most often done **laparoscopically**.