MEDICAL EDUCATION RESOURCE

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

      Volume 2, BD Chaurasia's Human …

      .

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.

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**

    Volume 2, BD Chaurasia's Human …

    .

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.

? 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.

? 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**.

? 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*).

- **Cholecystokinin-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.

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.

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.

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.*

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.

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.

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.

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.

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).

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.

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.

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**.

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.

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.

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.

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.

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).

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)

---

2. What is the function of the gallbladder?

- Stores and concentrates bile.
- Contracts during digestion (especially after fatty meals) under the action of **cholecystokinin (CCK)** to release bile into the duodenum.

---

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)

---

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**.

---

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.

---

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.

---

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**.

---

11. How is the gallbladder drained venously?

- Upper surface ? directly into liver substance.
- Lower surface ? via cystic veins into portal vein.

---

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.

---

14. What are the functions of bile?

- Emulsification of fats.

- Neutralization of gastric acid in the duodenum.
- Excretion of bilirubin and cholesterol.
- Aids in absorption of fat-soluble vitamins (A, D, E, K).

---

15. What are Rokitansky–Aschoff sinuses?

- Small mucosal diverticula that extend into the muscular wall of the gallbladder.
- Commonly seen in **chronic cholecystitis**.

---

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).

---

18. What is biliary atresia?

- Congenital absence or obliteration of bile ducts due to failure of recanalization.
- Leads to neonatal jaundice and cholestasis.

---

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).

---

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.

---

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.

---

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**.