

LIVER AND PANCREAS

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THE LIVER

It is the largest organ in the body.

RELATIONSHIPS

- **Superiorly:** hepatic veins
diaphragm
- **Postero-inferiorly** [visceral surface]: abdominal oesophagus
stomach
pylorus & duodenum
gallbladder
hepatic flexure of transverse colon
right kidney
right adrenal [suprarenal]
- **Posteriorly:** bare hepatic area
inferior vena cava
diaphragm
right adrenal
- **Anteriorly:** 7th-12th ribs
costal cartilages
diaphragm

ANATOMIC LOBES

A small **left lobe** and a larger **right lobe** separated anterosuperiorly by the **falciform ligament** which conveys the **ligamentum teres** [remnant of the umbilical vein] at its free edge and posteroinferiorly by an **H-shaped arrangement** formed by:

anterior right limb of H → **gallbladder**

anterior left limb → fissure of **falciform ligament**

between these two is the **quadrate lobe**

posterior right limb → **inferior vena cava**

posterior left limb → **ligamentum venosum** [remnant of the ductus venosus, origin of lesser omentum.

Between these two is located the **caudate lobe**.

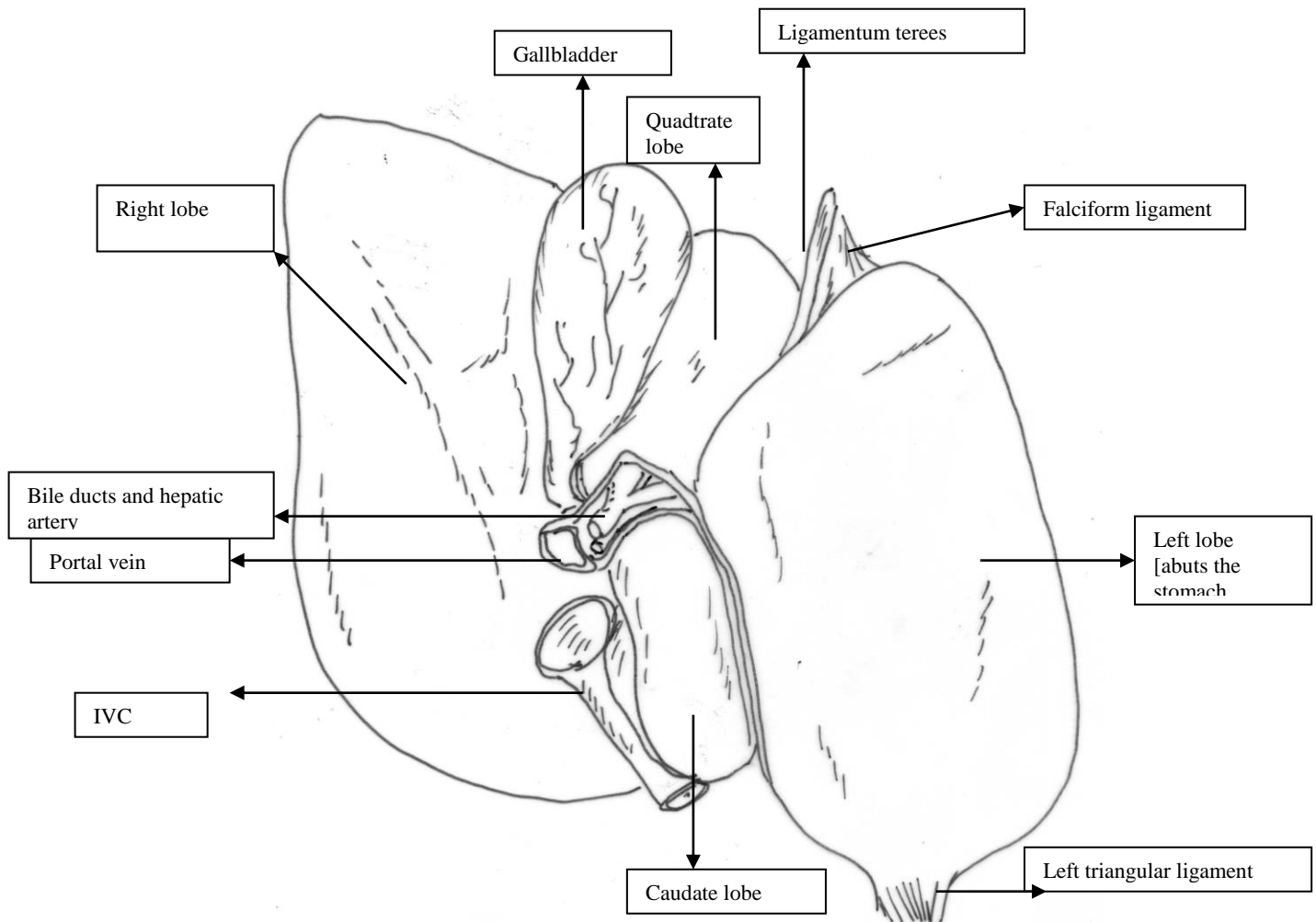
cross bar → **porta hepatis**, 5cm long

The liver hilum is connected with the duodenum via the **hepatoduodenal ligament** which conveys the **portal triad**:

- a. **common hepatic duct** [anteriorly]
- b. **hepatic artery** [superiorly and to the left]
- c. **portal vein** [posteriorly and in the middle]

PERITONEAL ATTACHMENTS [LIGAMENTS]

The liver is almost totally enclosed by peritoneum, except for a small posterior triangular bare area from where the peritoneum is reflected to the diaphragm.



- *The infero-posterior surface of the liver [elevated cephalad].. The quadrate and caudate lobe with the porta hepatis form an H-shaped area.*

- **FALCIFORM LIGAMENT**

Ascends to the liver from the **umbilicus**, bearing the **ligamentum teres** at its free border. Posteroinferiorly it enters in a groove which separates the left and right lobes [left anterior limb of H]. Anterosuperiorly it passes over the **dome of the liver** and then the two peritoneal layers which comprise it separate; to the left the **left triangular ligament** is formed which is attached superiorly to the **diaphragm** while posteriorly it joins the **anterior layer of the lesser omentum** which arises from the **ductus venosum** and the **porta hepatis**; to the right it fuses with the **upper layer of the coronary ligament**.

- **CORONARY LIGAMENT**

Arises as two separate sheets [upper and lower layer] from the **bare area** and is immediately attached to the **diaphragm**. From its left side [base] which separates the inferior vena cava from the caudate lobe arises the **peritoneum covering the posterior surface of the lesser sac**. Its upper [superior] layer fuses with the right limb of the **falciform ligament** and far to the right it joins its inferior [lower] layer, forming the **right triangular ligament**. The inferior layer is reflected from the liver and diaphragm to the right kidney and adrenal [**hepatorenal ligament**] and then crosses the inferior vena cava and fuses with left part of the coronary ligament and the posterior peritoneal layer of the lesser sac.

- **HEPATODUODENAL LIGAMENT [LESSER OMENTUM]**

Arises from the fissure at the **porta hepatis** and the **ligamentum venosum** as a **double peritoneal layer**. The **anterior sheet** covers the **portal triad** and comes to be attached to the **lesser curvature** of the stomach. The **posterior sheet** covers the caudate lobe and comes to fuse with the left side of the coronary ligament. With the inferior layer of the coronal ligament and the descending sheet of the left triangular ligament it covers the posterior wall of the lesser sac [**omental bursa**].

PORTA HEPATIS [cross bar of H]

As the portal triad ascends to the liver, the **common bile duct** is to the right, the **hepatic artery** to the left and the **portal vein** in the middle and posteriorly. Then the components of the triad branch and rebranch dichotomously [the left branch of the portal vein differs a little].

The hepatic artery is a branch of the **coeliac axis**. As it ascends to the liver hilum it bifurcates in the **triangle of Callot** [cystic duct, liver edge, hepatoduodenal ligament] to the **left and right hepatic arteries**. The **cystic artery** is usually a branch of the right hepatic artery.

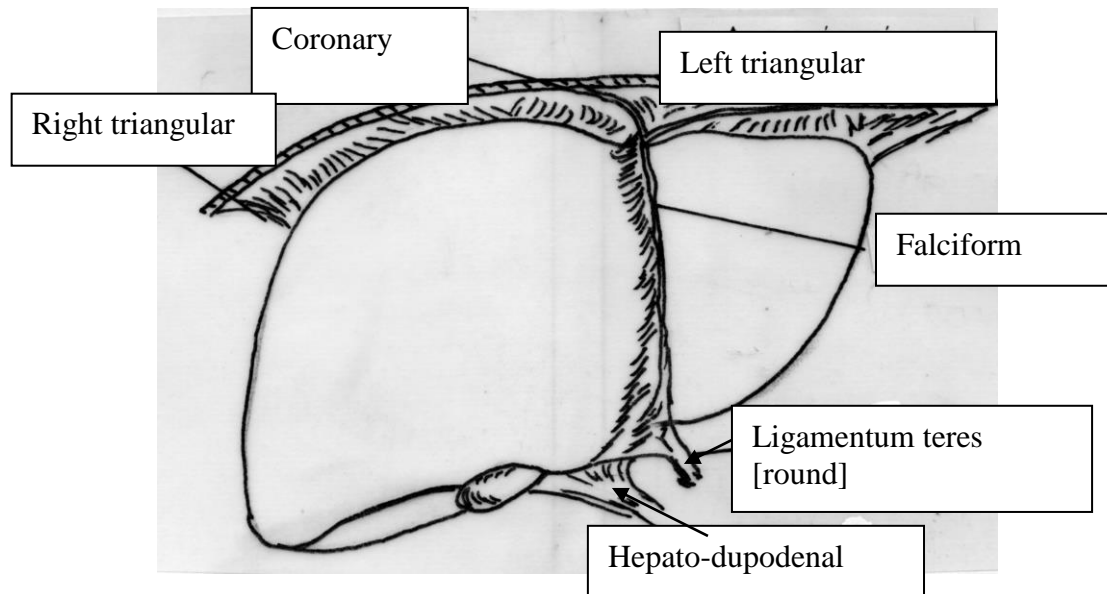
There are many anatomic variations in the hepatic artery:

- “normal anatomy” [the right hepatic is crossed by the bile duct] 54%
- aberrant left hepatic artery [branch of the left gastric] 11%
- right hepatic originating from the superior mesenteric 12%
- right hepatic crossing ventrally the bile ducts 14%
- right hepatic passing behind the portal vein 9%

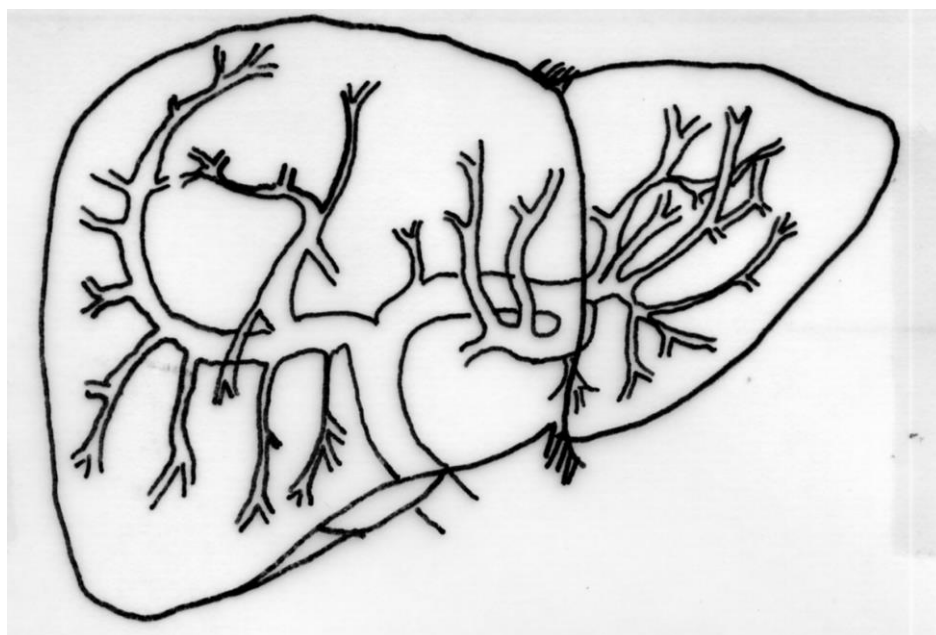
STRUCTURE OF THE LIVER

It is made up of **lobules** each containing a **solitary central vein** [tributary to the hepatic veins]. Between the lobules are the spaces called **portal canals** which contain **branches of the portal**

triad [bile ducts, arteries and portal vein branches] The arterial and portal branches drain into the central vein by means of **sinusoids** which transverse the lobule.



- *The ligaments of the liver*



- *Intrahepatic course of portal vein*

THE HEPATIC VEINS

Their distribution is different from that of the portal triad components. The central veins join and form the **3 major hepatic veins** which drain to the **inferior vena cava** at the dome of the liver [joining it at an almost vertical line]. Each vein corresponds to the left, middle and right thirds of the liver. The **middle hepatic vein** lines at the plane that passes vertically posteriorly from the gallbladder bed [**principal median plane**] and often joins the left hepatic before joining the IVC. Hepatic veins have no valves

There are also some small **short direct vein tributaries** which drain directly to the IVC distally to the hepatic vein confluence with the IVC.

SEGMENTAL HEPATIC ANATOMY

The liver is divided into two **functional lobes [left and right]** by a plane passing from the gallbladder fossa [anteriorly] to the inferior vena cava [posteriorly] which is called the **principal median plane** and its anterior line is called **median fissure**.

As the portal triad bifurcates at the hilum, the branches pass laterally and medially traversing horizontally the liver substance at its middle line. This theoretical transverse line is called horizontal fissure and divides the liver in superior and inferior parts. By two vertical lines corresponding to the roots of the right and left hepatic veins [right fissure and porto-umbilical fissure at the falciform ligament attachment] the superior and inferior parts are further divided into hepatic segments.

From the transverse fissure the portal triad components spread upwards and downwards to supply the segments. The only exception is the umbilical branch of the left portal vein which succumbs medially and anteriorly to supply the left medial segments.

With this segmental division the caudate lobe is partly to the left and partly to the right while the quadrate lobe is part of the left lobe.

SEGMENTS:

Left lobe: I. medial part of caudate lobe [**left medial inferior segment**]

II. **left lateral superior** [upper half of the “anatomic” left lobe]

III. **left lateral inferior** [lower half of the “anatomic” left lobe]

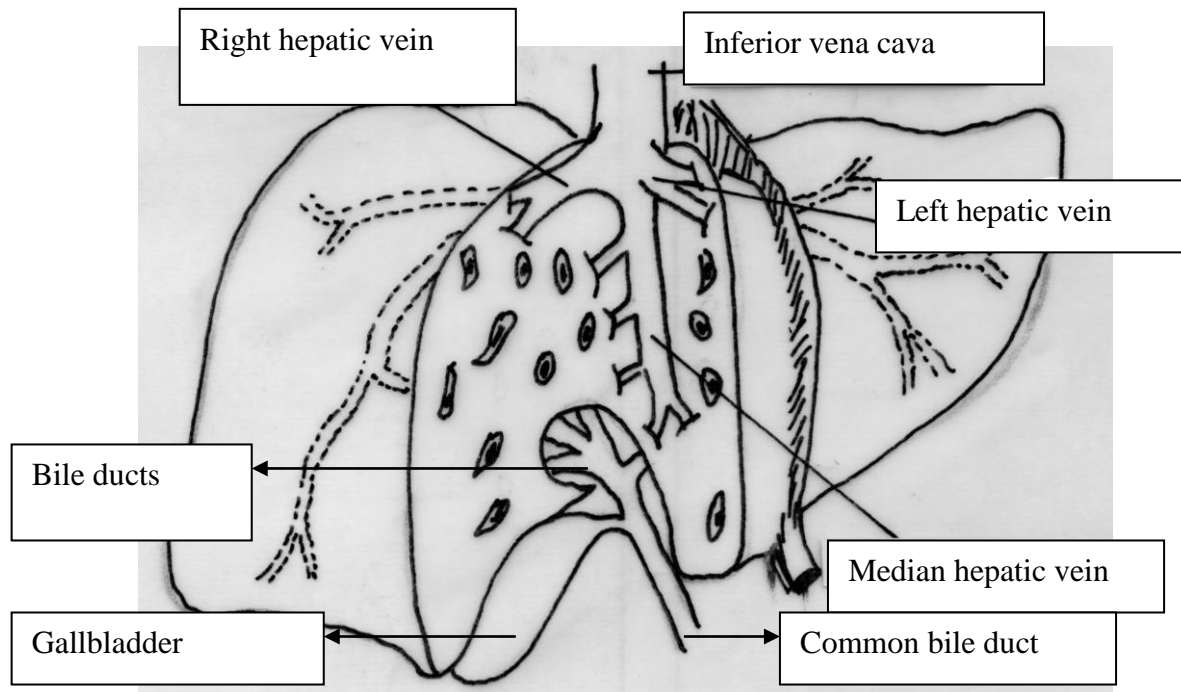
IV. **left median** or **medial superior** [segment between the portoumbilical fissure and the median plane]

Right lobe: V. **right anterior inferior** [between median and right fissure]

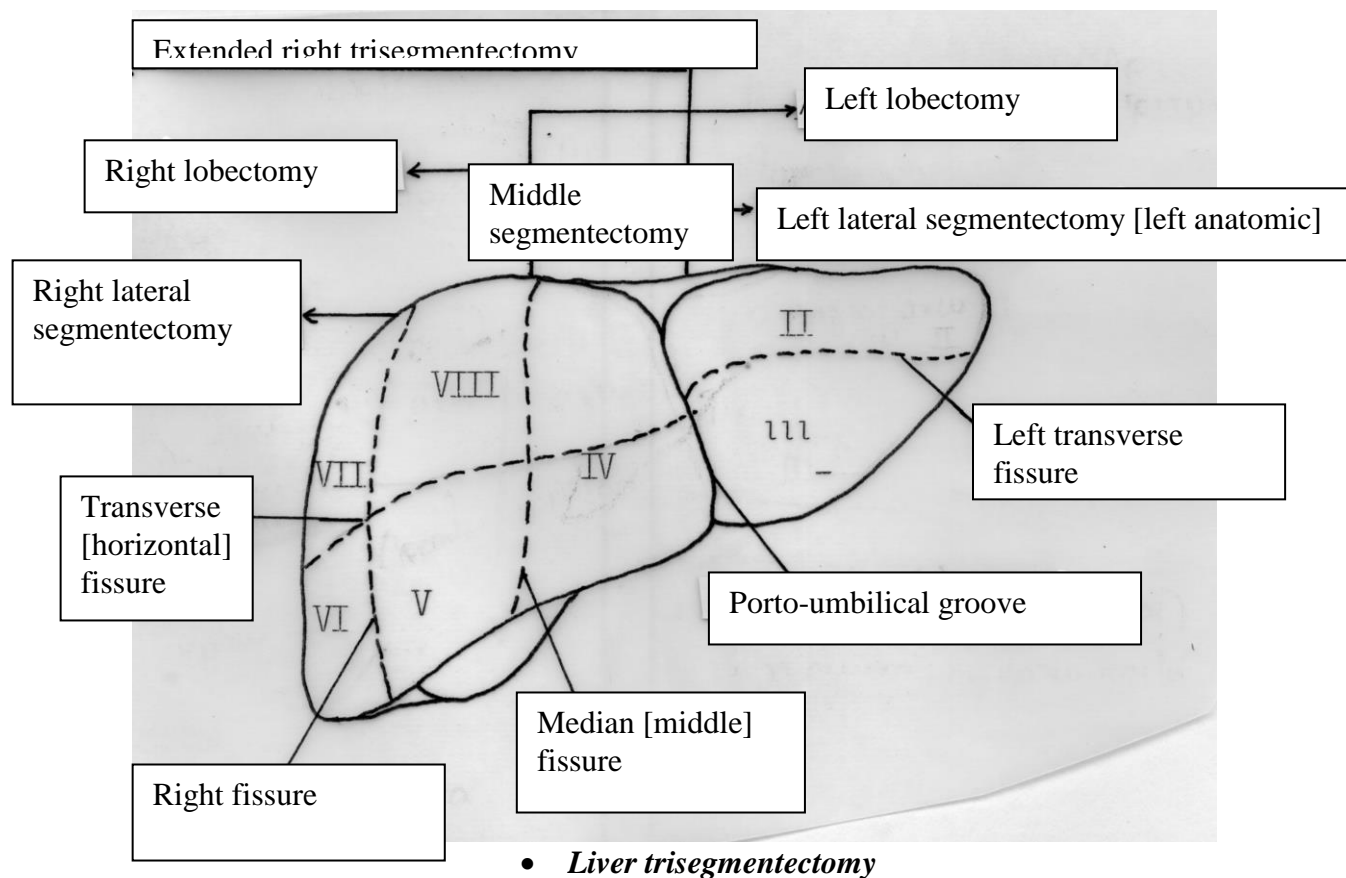
VI. **right posterior inferior** [lateral to the right fissure]

VII. **right posterior superior**

VIII. **right anterior superior**



- *The hepatic veins*



THE BILIARY TREE

The **small biliary passages** within the **portal canals** of the liver join to form **ductules** and then larger ducts which, finally, form the **left and right hepatic ducts**. They fuse at the porta hepatis forming the **common bile duct** [4cm long] which receives the **cystic duct** and becomes the **common bile [choledochal] duct** [10cm]. The latter usually commences 4cm above the duodenum, passes behind it in a groove in the head of the pancreas [or is embeded to it] and usually joins the **main pancreatic duct [Wirsung]** to open through a dilated common vestibule, the **ampulla of Vater**, at the second [descending] part of the duodenum. The orifice is guarded by the **sphincter of Oddi** [9cm from the pylorus]. In 5% of the subjects the choledochal and main pancreatic duct open through separate orifices.

From the inside view [duodenal lumen] two papillae are evident: the **large papilla [ampulla]** with a hood over it and a fold descending from it and the **lesser [small] papilla** which is located anterosuperiorly to the large through which opens the **accessory pancreatic duct of Santorini**.

THE GALLBLADDER

Acts as a concentrating reservoir and contains 50ml of bile.

Lies in a **fossa on the antero-inferior liver surface** where the **median fissure** divides the two functional liver lobes and is closely related to the **duodenum** and **transverse colon**. Its wall

contains muscle cells and is lined by **columnar mucosa** with a honeycomb surface, due to the presence of mucous secreting glands.

The **cystic duct** is a sinus connecting the gallbladder to the **common bile duct**; its mucosa forms spiral folds called **spiral valves**.

For descriptive purposes the gallbladder is divided into **fundus**, **body** and **neck**. Just proximal and ventrally to the latter an outpouch is formed, the **pouch of Hartman**, the usual place of stone lodgement.

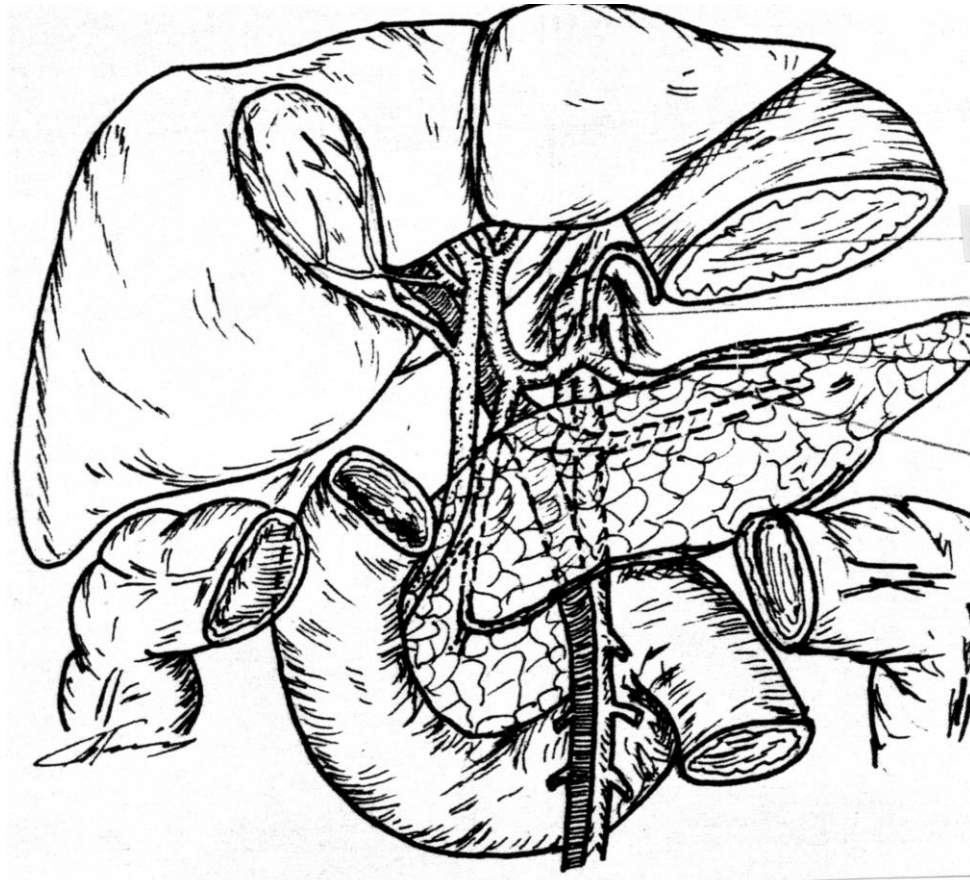
Its blood supply is usually received by the **cystic artery**, a branch of the **right hepatic artery** which can be identified in **Callot's triangle** [cystic duct, common hepatic duct and border of the liver] in about 75% of subjects. However, many variations are possible. Small arterial twigs supply the gallbladder through its **liver bed**. This is the reason why, despite the commonly occurring thrombosis of the cystic artery during inflammation, gangrene is extremely rare.

DEVELOPMENT OF BILE DUCTS & PANCREAS

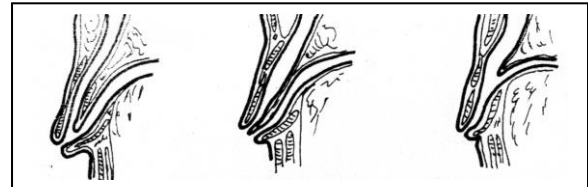
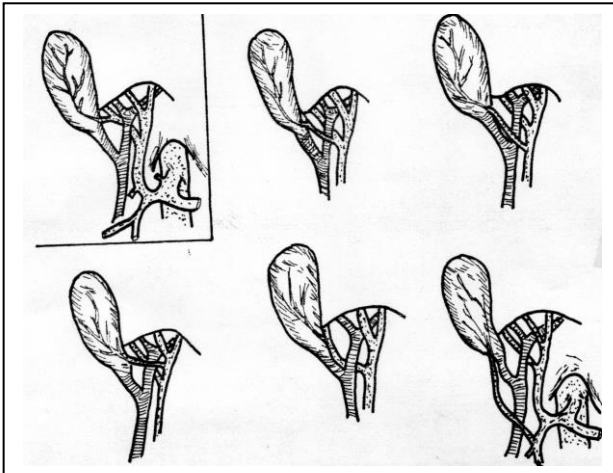
From the distal end of the **foregut** [which will form the duodenum up to the ampulla of Vater] arises a **ventral hepatic diverticulum** which differentiates into liver and biliary tracts. Another diverticulum protrudes from this hepatic bud which will become the gallbladder and the cystic duct.

Another ventral bud develops from the hepatic diverticulum [**ventral pancreatic diverticulum**] while the **primitive dorsal pancreatic bud** develops independently from the duodenum. As the duodenum rotates on its long axis the ventral pancreas and the bile duct come to lie posterior to the dorsal bud, trapping thus the superior mesenteric vessels. The two pancreatic ducts are connected; the duct of the dorsal bud atrophies or becomes the accessory duct of Santorini while the ventral duct [Wirsung] becomes the main duct of the pancreas.

Congenital anomalies



- *Anatomy & relations of gallbladder, bile ducts & pancreas*



- *Variations of sphincter of Oddi*

- *Cystic artery variations*

1. Extensive variations in bile ducts [i.e. accessory ducts, long cystic duct parallel to the bile duct, anomalous connections, etc]
2. Double or folded gallbladder, absence of cystic duct etc.
3. Annular pancreas: the ventral and dorsal buds form a ring completely surrounding the duodenum.

THE PANCREAS

A **retroperitoneal** organ lying in the **transpyloric plane** [L1], which is morphologically divided into **head** [lying in the medial side of the C-curve of the descending part of the duodenum], **neck** [short segment anterior to the mesenteric vessels], **body** [overlying the splenic vein] and **tail** which abuts the **splenic hilum**. The **uncinate process** passes from the inferomedial edge of the head behind the mesenteric vessels. The choledochal duct passes through the head to open in the duodenal ampulla.

RELATIONS

Anteriorly: lesser sac and stomach

Inferiorly: transverse mesocolon

Left: spleen, kidney

Right: duodenum, inferior vena cava

Superiorly: left adrenal, coeliac axis, coronary gastric vein

Posteriorly: inferior vena cava, diaphragmatic crura, superior mesenteric artery & vein, coeliac plexus, splenic artery [upper border of pancreas], splenic vein, portal vein [commencement], inferior mesenteric vein, common bile duct.

BLOOD SUPPLY

ARTERIES

- **superior pancreaticoduodenal artery**, branch of the gastroduodenal, dividing in anterior and posterior branch descending on each side of the medial duodenal curvature
- **inferior pancreaticoduodenal artery**, the first branch of the superior mesenteric, bifurcating in two branches [anterior, posterior] which ascend along the duodenal curve
- **dorsal pancreatic artery**, a branch of the splenic
- **small twigs** from the superior mesenteric and splenic

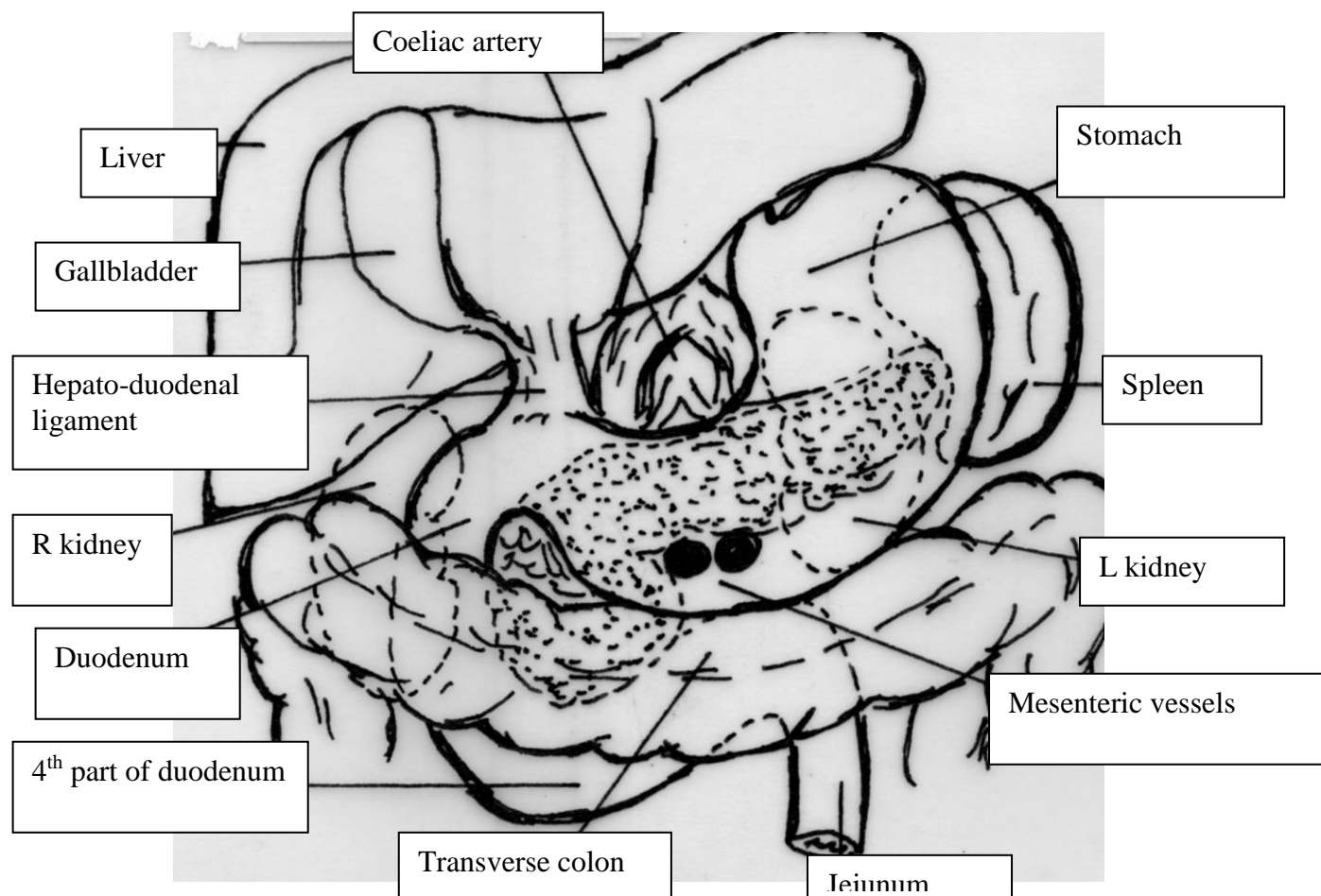
VEINS

Accompany the arteries

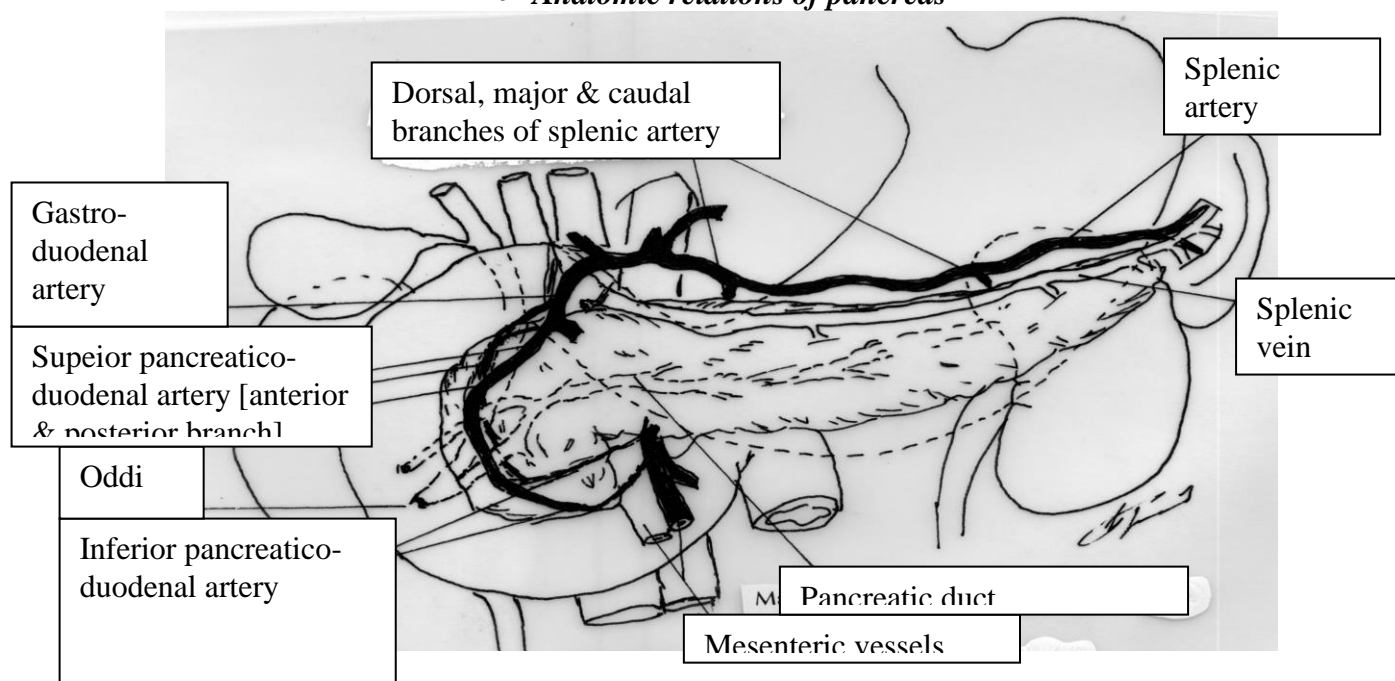
LYMPHATICS

- **Superior pancreatic** along its upper border
- **Pancreaticoduodenal**, between the head of the pancreas and the duodenum
- **Superior mesenteric**, at the root of the mesenteric vessels

They all drain to the **coeliac nodes** and finally to the **preaortic nodes**.



• *Anatomic relations of pancreas*



• *Vasculature of pancreas*

STRUCTURE

The pancreas is a lobular organ surrounded by a fine capsule.

The serous secretory **pancreatic acinar cells** form alveoli which drain through ductules into the principal duct. Between the acinar cells are small **islets [Langerhans]** secreting **insulin**. There are also some specially differentiated cells which secrete various **parahormones**.

THE SPLEEN

Has the size of a cupped hand and lies below the 9th -11th ribs. Its border is circumferential with notches characterising the superior border. Forms the left border of the lesser sac. The **gastrosplenic ligament**, conveying the short gastric and left gastrepiploic vessels connects it to the gastric fundus; the **splenocolic ligament** connects its inferior pole to the splenic flexure of the transverse colon while the **splenorenal ligaments [lieno-renal]** connects it to the posterior abdominal wall.

In 10% of the subjects there are accessory spleens. The most common positions [in order of frequency] are: splenic hilum, tail of pancreas, splenic mesentery, omentum, small bowel mesentery.

RELATIONS

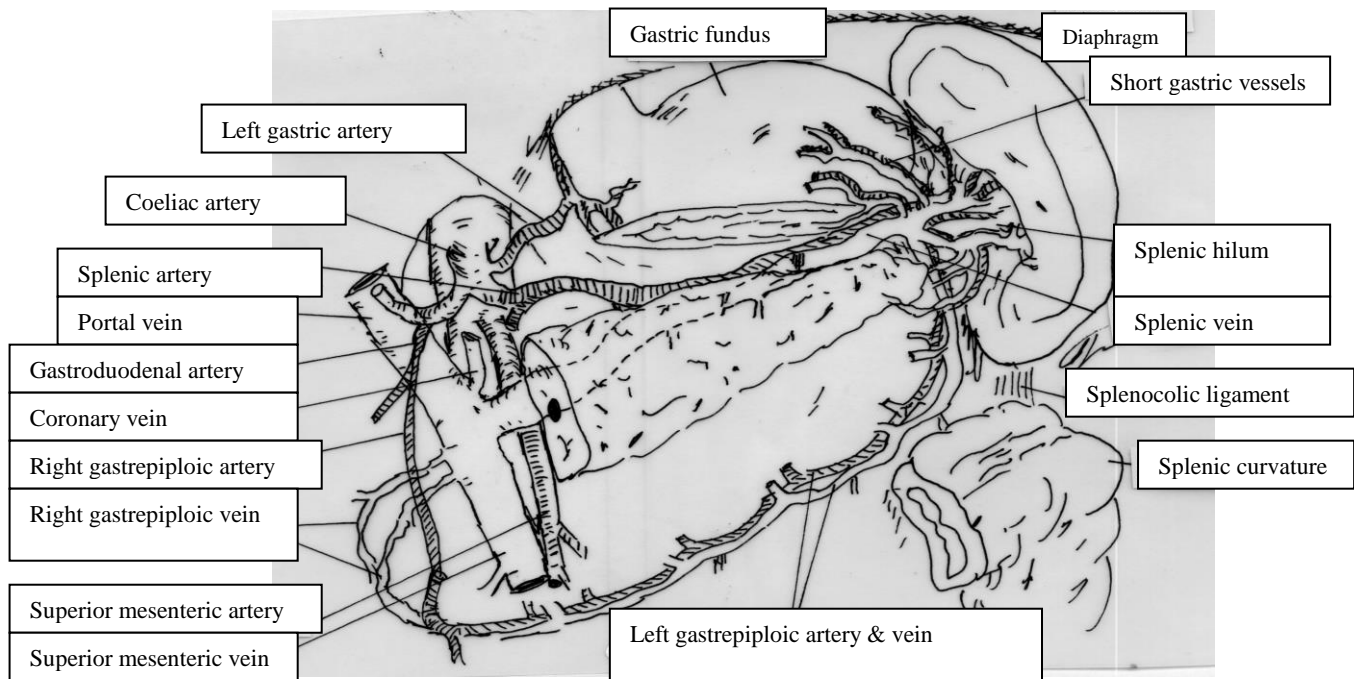
- **Posteriorly** left diaphragm, 9th-11th ribs
- **Anteriorly** stomach, costal cartilage, ribs
- **Inferiorly** splenic flexure
- **Medially** pancreas, kidney, stomach [lesser sac]
- **Laterally** diaphragm, ribs

BLOOD SUPPLY

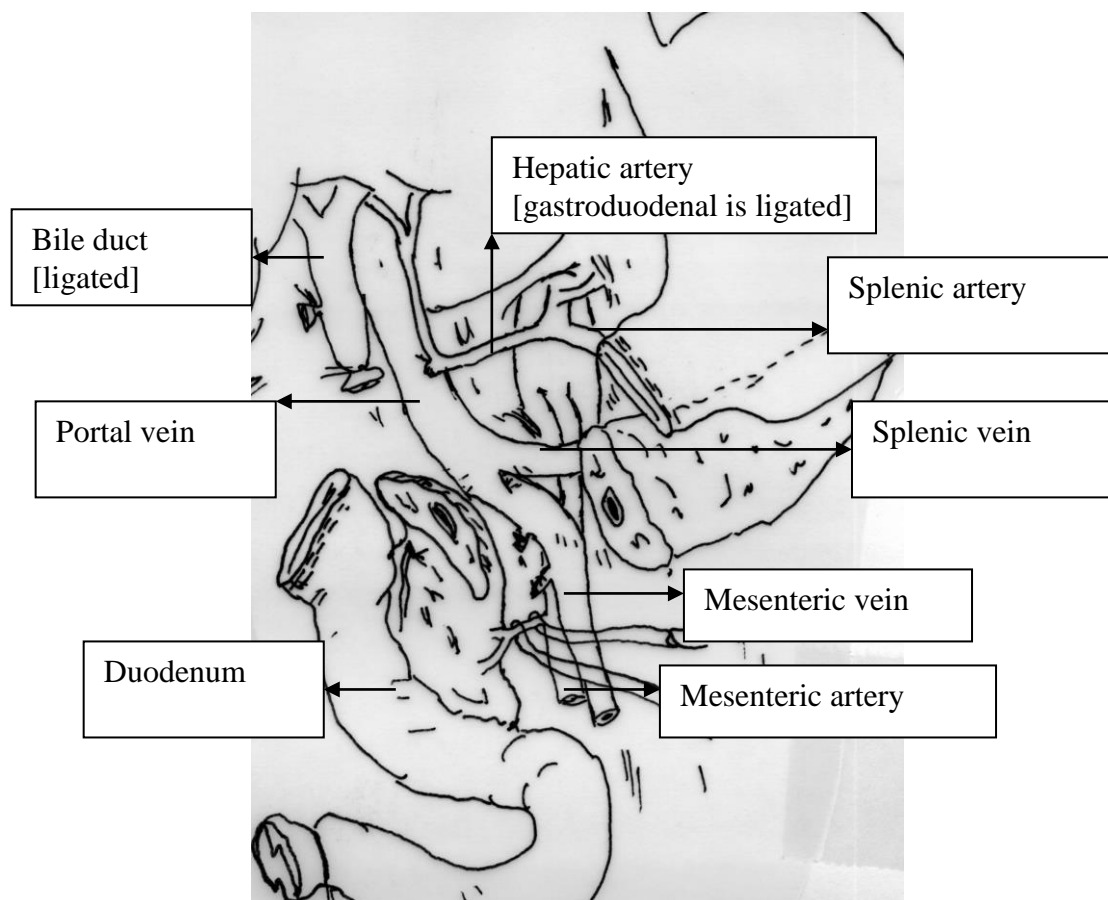
- **Splenic artery**, branch of the **coeliac axis** which travels to the left along the superior border of the pancreas and at the splenic hilum it gives off the **left gastrepiploic artery** and the **short gastric arteries** both of which communicate with the right gastrepiploic artery [branch of the gastroduodenal] forming a network along the greater curvature of the stomach.

STRUCTURE

The spleen is the largest **reticuloendothelial organ**. Its thin **fibrous tissue** capsule extends into the spleen, forming a series of **trabeculae** which contain the **splenic pulp**, red or white.



• *Anatomic relations & blood supply of spleen*



• *The structures behind pancreas [after Whipple]*

THE KIDNEY AND URINARY TRACT

THE KIDNEYS

They are bean shaped **retroperitoneal** organs, 4x6x11cm in dimensions, located between the **T12-L2 levels**. The right is situated 12mm lower, due to the bulk of the liver. Their hilum lies on the **transpyloric plane [L1]**.

MACROSCOPIC ANATOMY

- The **hilum** presents as a deep vertical slit at the medial aspect of the kidney. The **renal sinus** is a pocket formed between the lips of the renal hilum. Through the hilum [from anterior to posterior] enter the **renal vein**, the **renal artery** and exits the **renal pelvis**. There is usually a subsidiary branch of the renal artery which passes behind the pelvis. In 25% of kidneys there are 2 or 3 **aberrant renal arteries**, originating from the aorta, which enter the organ either through the hilum or its lower pole.
- The **renal [ureteric] pelvis** might be either buried in the renal hilum or be completely outside it [in the latter, removal of stones through pyelotomy is far easier]. Inside the kidney the pelvis divides into 2-3 **major calyces**, each of which divides into **minor calyces**. Each kidney has 7-14 minor calyces. Each one of them receives a **papilla** [apex of the red pyramid] which discharges urine into the calyx. On cross section the **red pyramids** [striated, containing collecting tubules and loops of Henle] represent the renal **medulla**. Between the pyramids are the **renal columns** which are a continuation of the **renal cortex** [the outer third of renal substance]. They are granular and contain glomeruli and convoluted tubules with the interlobular arteries between them.
- **Renal artery**: arises from the aorta at L1 level. The right passes posteriorly to the inferior vena cava. Its branches are terminal vessels without any cross-communication.
- **Renal veins**: the left passes in front of the aorta, behind the superior mesenteric vessels, in the root of the transverse mesocolon. It receives the left suprarenal and the left spermatic vein. Occasionally it follows a retroaortic route. It also communicates with the lumbar veins of the area. The right renal vein has a short course [2-3cm] before joining the IVC.
- **Lymphatics**: they drain directly to the preaortic nodes
- **Nerves**: receive sympathetic vasomotor fibers, entering through the hilum.

RENAL FASCIA

There are 3 or four renal coverings:

1. The **perinephric fat**, exterior to the renal fascia
2. The **fatty renal capsule** which is subdivided in:
 - a. **renal fascia**
 - b. **perirenal fat**, contained within the renal fascia
3. The **true fibrous renal capsule**, adherent to the organ

The kidney lies in an abundant fatty cushion. The renal fascia blends superiorly with the diaphragm, leaving although a compartment for the suprarenal. Medially, it blends with the aortic and vena cava sheaths respectively. Posteriorly and laterally it is continuous with the **fascia**