

**Associations of the liver:**

*Diaphragmatic surface:*

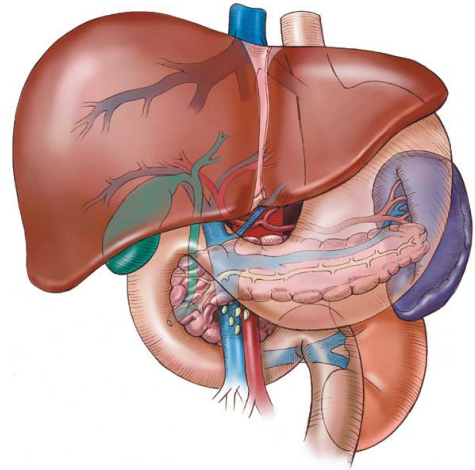
- Right lobe
- Central tendon (and overlying heart)

*Right visceral surface (surface of hepatorenal space):*

- Duodenum
- Hepatic flexure of colon
- Right kidney
- Suprarenal glands

*Left visceral surface:*

- Oesophagus
- Stomach



**Associations of the gall bladder:**

*Body of gall bladder:*

- *Front:* transverse colon
- *Behind:* first part of duodenum

**Blood supply to gall bladder:**

- Cystic artery
- Vessels from liver

**Associations of the stomach:**

*Anterior:*

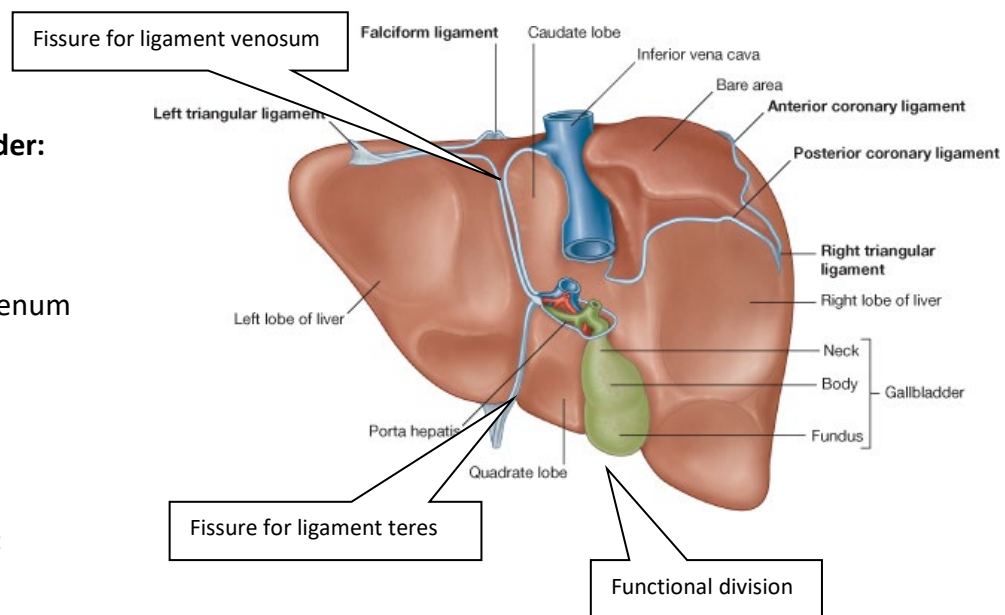
- Liver
- Diaphragm
- Anterior abdominal wall

*Posterior:*

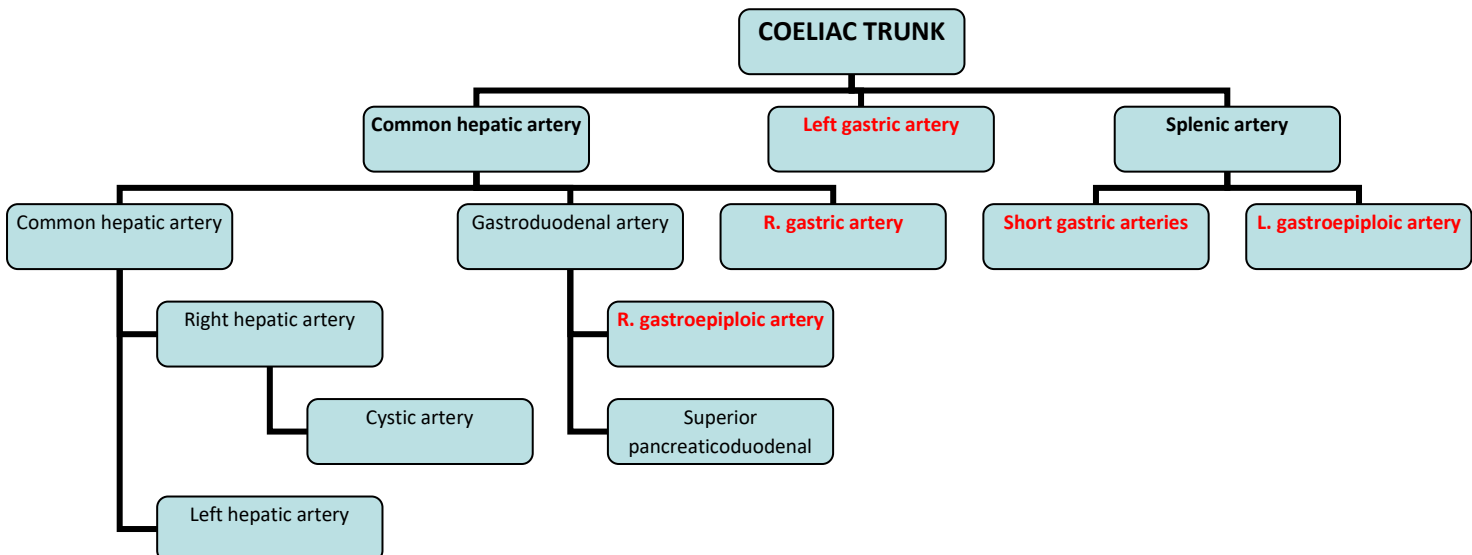
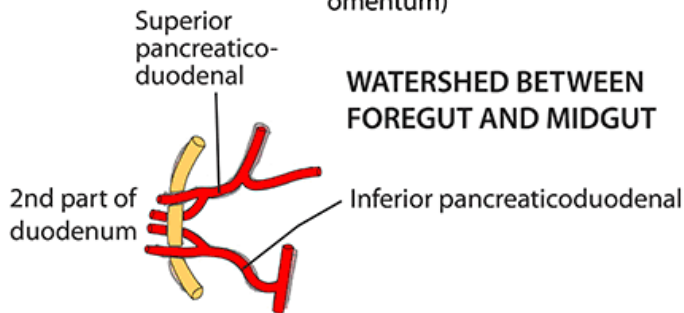
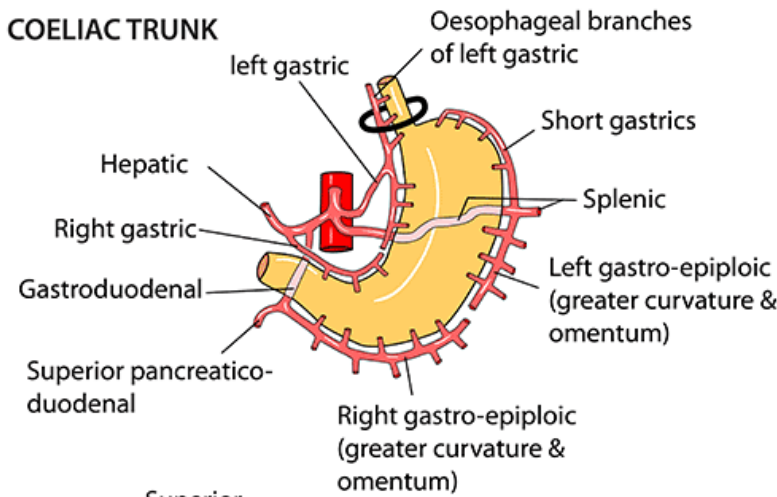
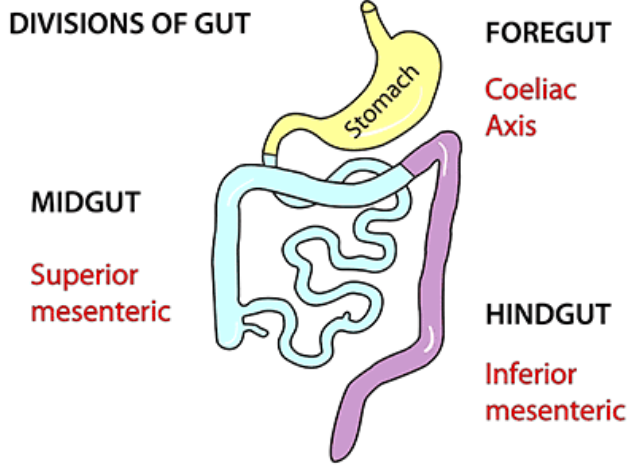
- Left crus
- Diaphragm
- Pancreas
- Left kidney + suprarenal gland
- Transverse colon
- Spleen

**ARTERIAL BLOOD SUPPLY TO STOMACH:**

See diagram below



**PRINCIPLES OF BOWEL ARTERIAL SUPPLY  
COELIAC TRUNK**



### **VENOUS DRAINAGE OF STOMACH:**

- Gastric veins all drain into the portal vein.

#### *Porto-caval anastomoses:*

- Anastomoses between veins of portal circulation and veins of the systemic circulation.
- Gastric veins drain the distal oesophagus
- **Distal oesophagus → azygos vein → SVC**
- **Stomach → portal vein**
- Venous obstruction in the portal vein / liver, blood flows:

Gut → hepatic portal vein → left gastric vein → (oesophagus) → azygos vein → SVC

- Distended gastric veins around umbilicus – **caput Medusae**.
- Can result in oesophageal varices & potential bleeding into lumen of oesophagus.

### **LYMPHATIC DRAINAGE OF STOMACH:**

- Drains in 3 directions:
  - Upwards towards cardiac sphincter
  - Downwards towards pyloric sphincter
  - Left and laterally towards spleen
- Chains of lymph nodes run along the main arteries:
  - Coeliac trunk group
  - Hepatic group
  - Splenic group
  - Left gastric group
- → all drains into coeliac group → thoracic duct

### **LYMPHATIC DRAINAGE OF GUT IN GENERAL:**

- Follows the arterial tree back towards the para-aortic lymph nodes → cisterna chyli → thoracic duct.

## AUTONOMIC NERVOUS SUPPLY OF THE STOMACH:

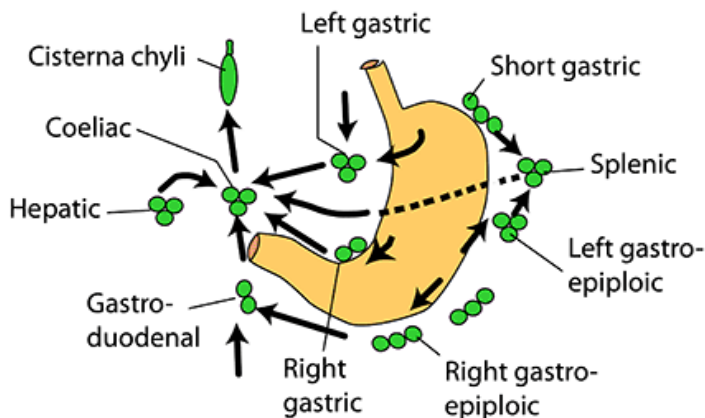
### *Sympathetic:*

- Thoracic splanchnic nerves (T5-T9)
- Synapse in the coeliac ganglia (around celiac trunk)
- Follows blood vessels to stomach
- Inhibit peristalsis and close pyloric sphincter

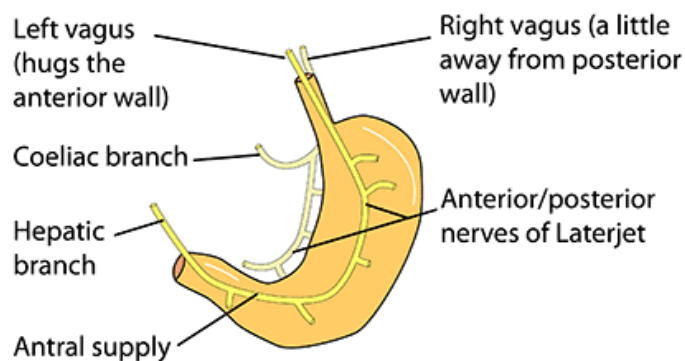
### *Parasympathetic:*

- Vagal trunks
- Right vagus → posterior oesophageal plexus (lower 1/3) → posterior gastric nerve
- Left vagus → anterior oesophageal plexus → anterior gastric nerve
- The gastric nerves (esp. anterior) innervate fundus, body and pylorus of stomach.
- Increase peristalsis, relax pylorus and secretomotor to secretory glands of stomach mucosa.

## STOMACH - LYMPHATIC DRAINAGE & NERVE SUPPLY



## STOMACH NERVE SUPPLY



**Vagus nerves** are 80% sensory.  
20% motor for increasing motility,  
opening pylorus & initiating  
secretions

**Sympathetics**  
Greater splanchnic nerves  
(T5-9) for decreasing motility,  
vasoconstriction, closing  
pylorus & sensation

Note: Highly selective vagotomy destroys vagus to  
fundus & body but preserves nerve to antral pump

<p><b>RIGHT HYPOCHONDRIAL REGION</b></p> <p>Liver and Gall bladder (Kidney) and suprarenal gland Colon – hepatic flexure</p>	<p><b>EPIGASTRIC REGION</b></p> <p>Liver (Transverse colon , hanging from transverse mesocolon) Abdominal aorta and vena cava Pylorus and Duodenum (1<sup>st</sup> part)</p>	<p><b>LEFT HYPOCHONDRIAL REGION</b></p> <p>Stomach Spleen (Kidney) and Suprarenal gland Colon – splenic flexure</p>
<p><b>RIGHT LUMBAR REGION</b></p> <p>Kidney Colon – ascending Small intestine</p>	<p><b>UMBILICAL REGION</b></p> <p>(Transverse colon) Duodenum and pancreas Abdominal aorta and vena cava Small intestine Iliac vessels</p>	<p><b>LEFT LUMBAR REGION</b></p> <p>Kidney Colon – descending Pancreas Small intestine (jejunum)</p>
<p><b>RIGHT ILIAC REGION</b></p> <p>Caecum Appendix Small intestine (ileum)</p>	<p><b>HYPOGASTRIC REGION</b></p> <p>Distensible organs of the pelvis eg. bladder in infants or in adults when full; uterus after 12<sup>th</sup> week of pregnancy. Small intestine Iliac vessels Spermatic cords</p>	<p><b>LEFT ILIAC REGION</b></p> <p>Sigmoid colon Small intestine</p>

### **DUODENUM:**

#### *FIRST PART:*

- Backwards
- Level of **L1** (transpyloric plane)
- Smooth walled
- Lesser omentum attached to upper surface
- Second ½ of first part is retroperitoneal

#### *SECOND PART:*

- Downwards
- Plicae circulares / valvulae conniventes
- In front of hilum of right kidney
- Major duodenal papilla (entrance of ampulla of Vater)
- Transverse mesocolon runs in front of it.

*THIRD PART:*

- Horizontal
- Level of **L3**
- Plicae circulares
- Is anterior to:
  - R psoas muscle
  - R gonadal artery and vein
  - R genitofemoral nerve
  - R ureter
  - Vena cava
  - Aorta
- Posterior to superior mesenteric artery (these run over the top of it)

*FOURTH PART:*

- **Ascending to L2**
- Rises out from behind peritoneum (no longer retroperitoneal)
- Is anterior to:
  - L psoas muscle
  - L gonadal artery and vein
  - L genitofemoral nerve
  - L renal artery + vein
- Plicae circulares
- Duodenojejunal junction (duodenal flexure)
- Suspended by '**suspensory ligament of the duodenum**' / '**ligament of Treitz**' from vertebral bodies next to **right crus**.
- **Superior and inferior duodenal fossae** (folds of peritoneum)

**L1 → descends to L3 → ascends to L2**

## DUODENUM - GENERAL

10" (25cm) Medieval Latin for 12 fingers

### SECOND PART (3" or 8cm)

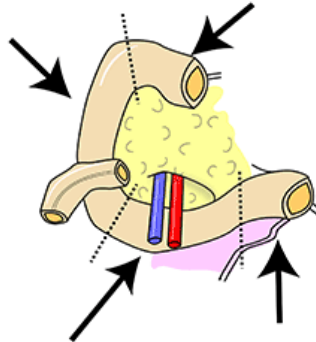
- Retroperitoneal
- In transpyloric plane
- Downwards over hilum of right kidney
- Anterior: Gallbladder, hepatic flexure
- Medial: Pancreas, ampulla (posteromedial, 4" or 10cm from pylorus)
- Lateral: Ascending colon

**Blood supply:** Superior & inferior pancreatico-duodenal arteries, right gastric artery, right gastro-epiploic artery

**Veins:** Splenic, superior mesenteric & portal

### FIRST PART (2" or 5cm)

- 1st 1/2 with mesentery, 2nd 1/2 without.
- Slightly longer in female
- Just above transpyloric plane
- Passes to right, upwards, backwards
- Anterior: Liver & gallbladder
- Superior: Epiploic foramen
- Inferior: Pancreas



### THIRD PART (4" or 10cm)

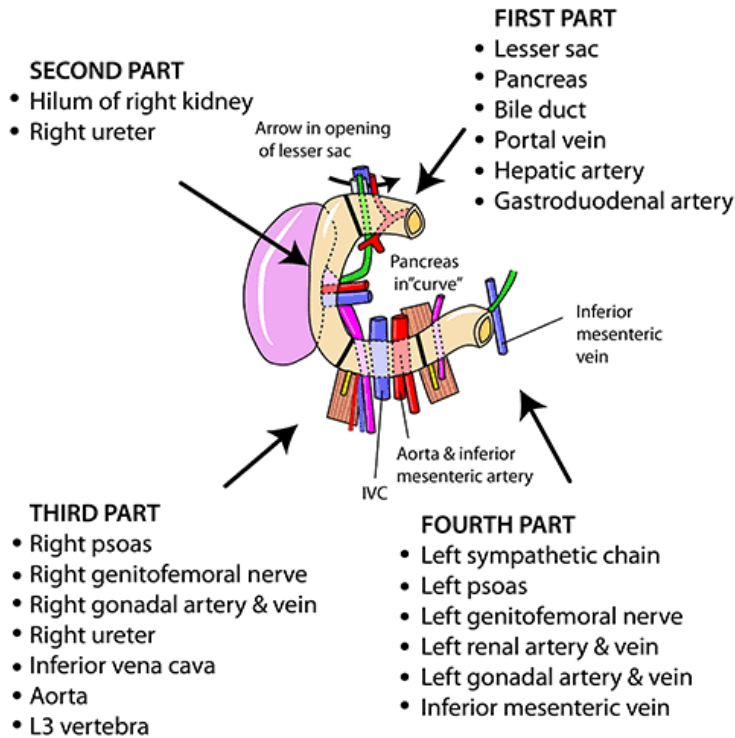
- Retroperitoneal
- Below subcostal plane
- Passes forwards & to left
- Anterior: Small bowel mesentery, superior mesenteric artery & vein
- Superior: head of pancreas
- Inferior: Jejunum

### FOURTH PART (1" or 2.5cm)

- Mesentery begins
- Ascends to L2
- Ends as duodenojejunal junction
- Anterior: Transverse colon & mesocolon
- Left: Left kidney & ureter
- Superior: Body of pancreas

## DUODENUM - POSTERIOR RELATIONS & LIGAMENT OF TREITZ

### POSTERIOR RELATIONS OF DUODENUM

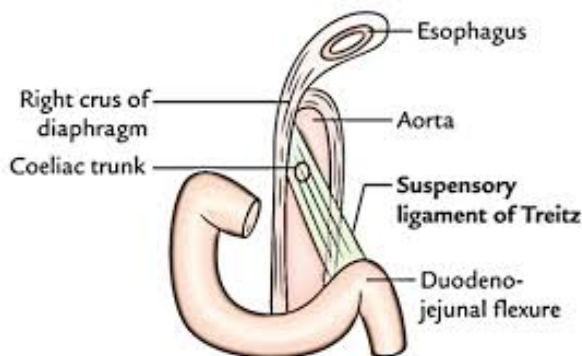


### LIGAMENT OF TREITZ

2 parts, probably neither attached to crura

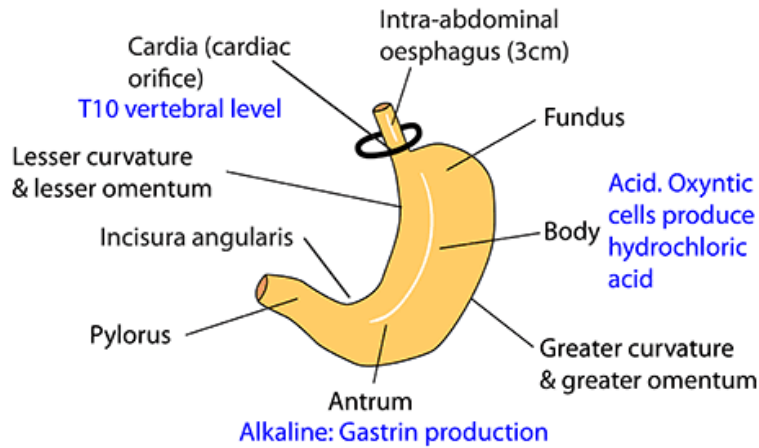
1. Slip of striated muscle from diaphragm at oesophageal opening, ending in connective tissue at coeliac artery
2. Fibromuscular (non striated) band from region of coeliac artery to duodenojejunal junction and 3th & 4th parts of duodenum

Referred pain via general visceral afferents in sympathetics to T8-10 (epigastric & para-umbilical)

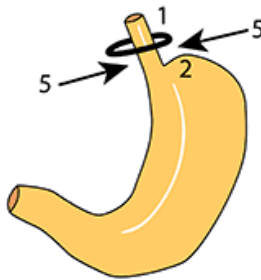




## STOMACH - TOPOGRAPHY & OESOPHAGOGASTRIC JUNCTION

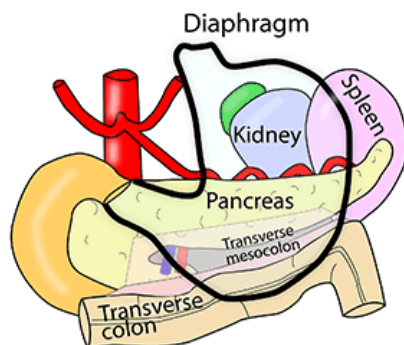


## FACTORS PREVENTING GASTRO-OESOPHAGEAL REFLUX



1. Crura. Mostly right but together giving effectively a circle of muscle
2. Angle of oesophagogastric junction
3. Apposition of mucosal folds
4. Phrenico-oesophageal ligament (a fold of connective tissue)
5. Intra-abdominal pressure acting laterally on small section of intra-abdominal oesophagus

## STOMACH - RELATIONS



### ANTERIOR

Abdominal wall  
Left costal margin  
Diaphragm  
Left lobe of liver

### SUPERIOR

Left dome of diaphragm

### POSTERIOR

Lesser sac  
Pancreas  
Transverse mesocolon  
Transverse colon  
Left kidney/suprarenal gland  
Spleen/splenic artery

#### BLOOD SUPPLY TO DUODENUM:

- Boundary between foregut and midgut is ½ way through duodenum
- → blood supply changes ½ way through
- Celiac trunk → Common hepatic artery → gastroduodenal artery → **superior pancreaticoduodenal artery**
- Superior mesenteric artery (branches above 3<sup>rd</sup> part of duodenum) → **inferior pancreaticoduodenal artery**

#### PANCREAS

- Retroperitoneal apart from its tail

#### Posterior associations of head and neck:

- Curvature of duodenum
- Aorta and VC
- Common bile duct (→ carcinoma in pancreas head can obstruct bile duct → obstructive jaundice)
- Portal vein
- Superior mesenteric artery

#### Associations of body:

##### Anterior

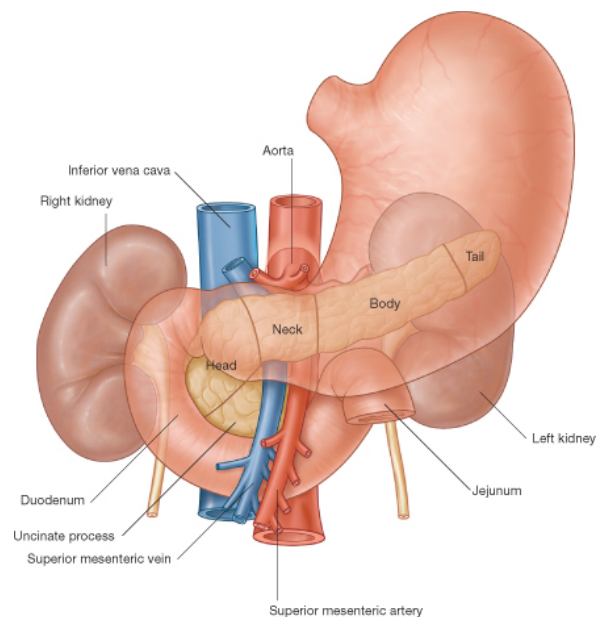
- Transverse mesocolon

##### Posterior

- Splenic artery
- Aorta
- Left kidney

#### Associations of tail:

- Within leaves of lienorenal ligament
- Hilum of spleen

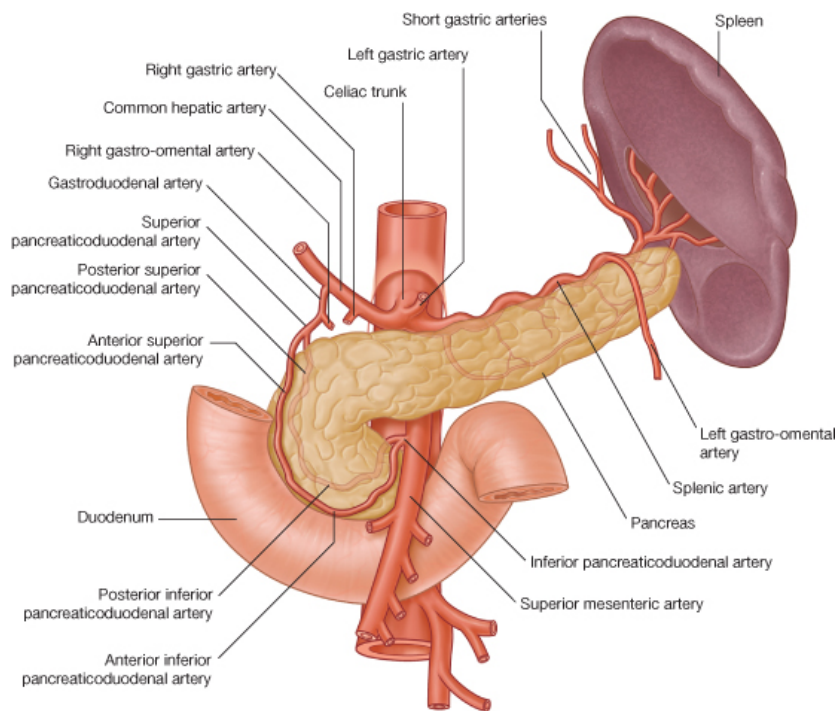
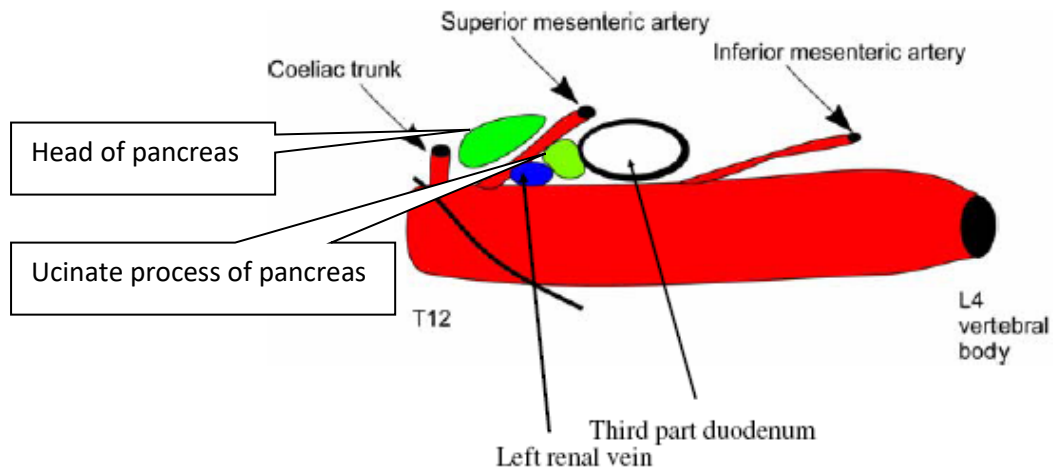


#### PANCREATIC BLOOD SUPPLY:

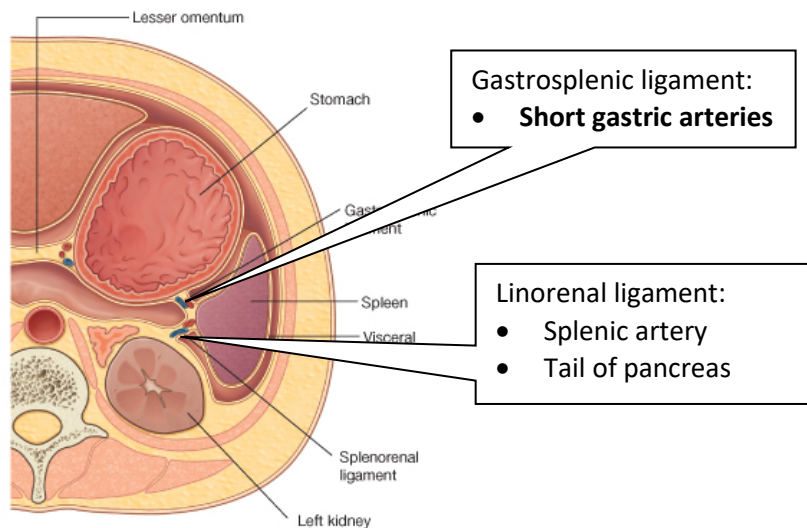
1. **Superior pancreaticoduodenal artery (from gastroduodenal artery of coeliac trunk)**
2. **Inferior pancreaticoduodenal artery (from superior mesenteric artery)**
3. **Branches of splenic artery**

#### SPLEEN:

- LHS – **entirely behind left axillary line**
- On diaphragm (diaphragmatic surface is smooth)
- Behind mid-axillary line
- Associated with ribs 9, 10, & 11
- Can only be felt protruding in front of these ribs when it is enlarged.
- Notched anterior border.

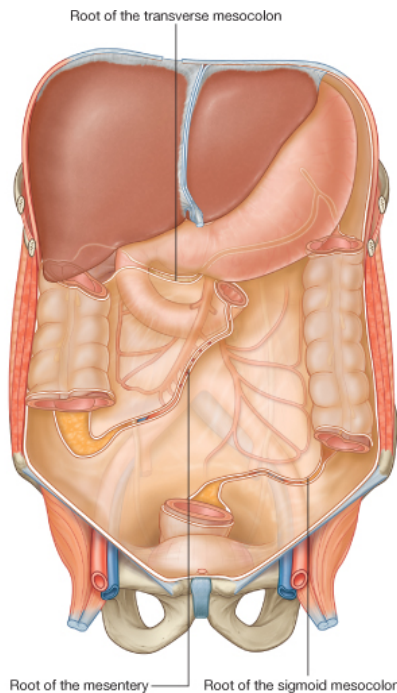


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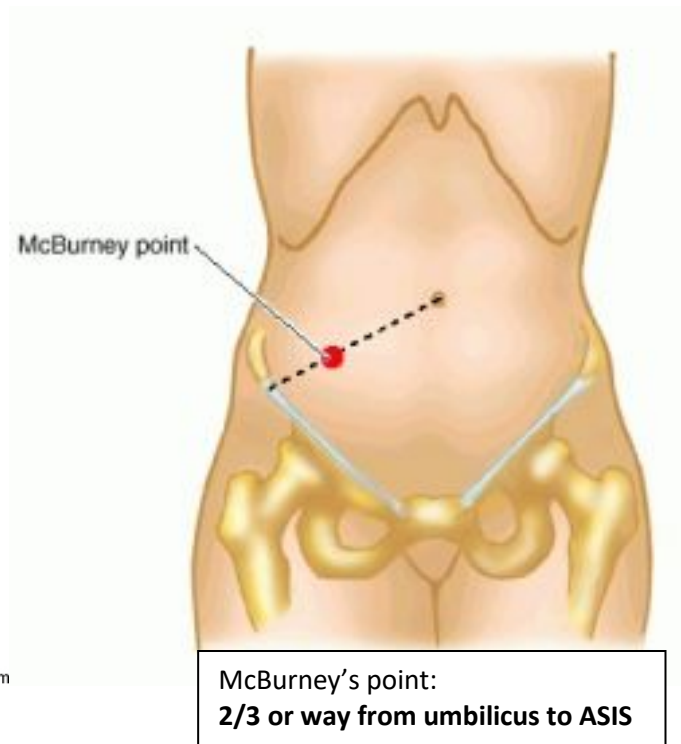


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**Linorenal = splenorenal ligament**



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Origin of small bowel mesentery:

- **Left of L2 vertebral body →**
- **S2 right sacroiliac joint**

#### **JEJUNUM:**

- More vascular (but fewer arcades)
- Thicker wall
- **Plicae circulares**
- Fat in mesentery does not run as close to jejunum as it does to ileum

#### **ILEUM:**

- Less vascular and less thick walled
- More vascular arcades
- More Peyer's patches in wall than jejunum.
- May have **Meckel's diverticulum** 0.5m from ileocaecal junction (remnant of embryological vitellointestinal duct).
- Meckel's diverticulum can become infected and present with all the symptoms of acute appendicitis.

## SMALL INTESTINE

- Average length 6 metres (20 feet)
- Range 3-10 metres (10-33 feet)
- Patients can survive with 2/3 removed. Little if any effect by removing 1/3



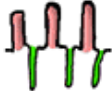

### ORIGIN OF SMALL BOWEL MESENTERY

15cm (6") long.

Starts at the duodenojejunal junction, just to left of L2 vertebra and extends down and to the right to right sacro-iliac joint at S2 sacral level. Contains superior mesenteric vessels, lymphatics and autonomic nerves.

BLOOD: Ileal & jejunal brs of superior mesenteric artery.

NERVES: General visceral afferents in lesser splanchnics (sympathetic) referred to T10 (para-umbilical)

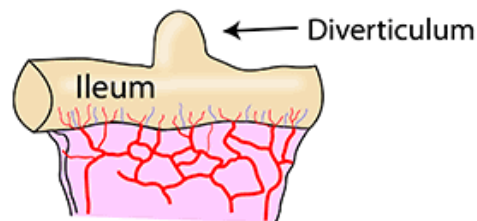
	JEJUNUM	ILEUM
<b>General</b>	2/5, red, wide bore, thick wall	3/5, pink, narrow bore, thin wall
<b>Macroscopic</b>	Valvulae conniventes, plicae circulares ++, sparse arcades	Smooth wall, Peyer's patches, multiple arcades
		
<b>Mesentery</b>	Lies superiorly, attached to left of aorta, less fat	Lies inferiorly, attached to right of aorta, fatty mesentery
<b>Histology</b>	Tall villi Long crypts	Short villi Short crypts
		

Note: At base of crypts are Paneth cells that produce lysozyme. Also terminal ileum is site for absorption of vitamin B12 and bile salts

## MECKEL'S DIVERTICULUM SMALL BOWEL MESENTERY SMALL BOWEL SECRETIONS

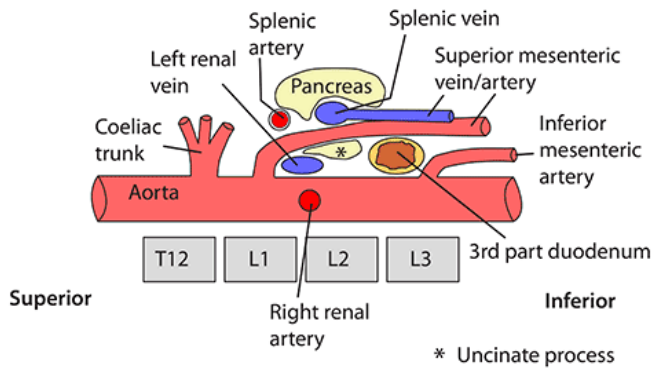
### MECKEL'S DIVERTICULUM

- Said to be present in 2-3% of people, 2-3 inches" long and 2-3 feet from the ileocaecal valve but these statements are probably only 2/3 true!
- May contain gastric, pancreatic, liver, carcinoid or lymph tissue
- May attach to umbilicus via a vitello-intestinal tract which may or may not leak but may cause intestinal obstruction as a volvulus can wrap around it
- Symptoms very similar to appendicitis
- Lies on antemesenteric border of ileum

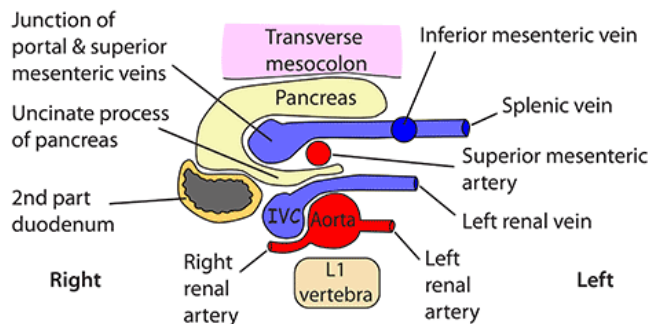


### AXIAL & LONGITUDINAL SECTIONS AT L1 VERTEBRAL LEVEL

#### LONGITUDINAL SECTION VIEWED FROM RIGHT

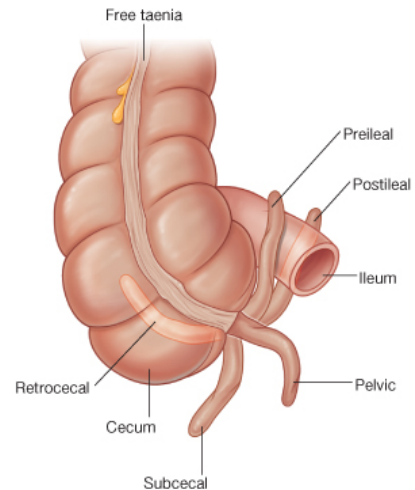


#### AXIAL (CROSS) SECTION AT L1 LOOKING UP

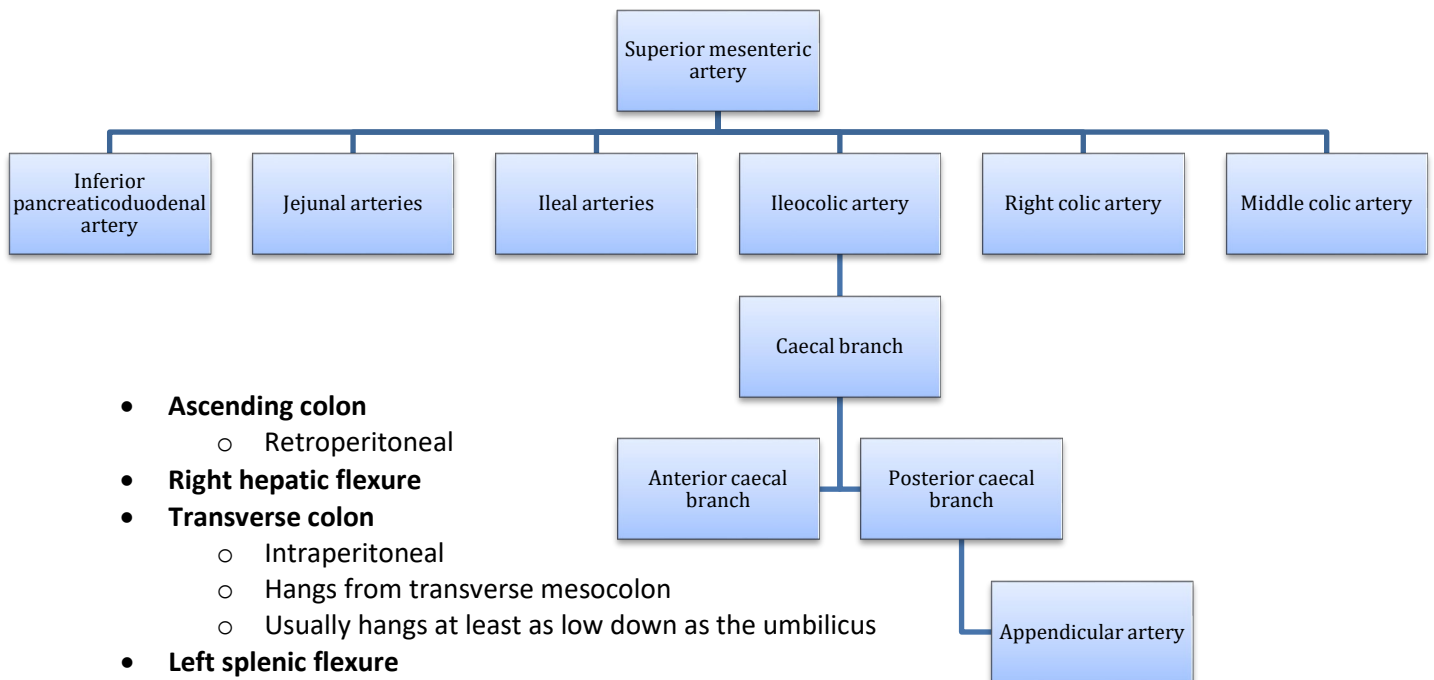


**LARGE INTESTINE:**

- Ileum enters caecum at **ileocaecal valve**
- Base of the appendix is at **McBurney's point**:
  - 2/3 way from umbilicus to ASIS
- Tip of appendix may be:
  - Retrocaecal
  - Paracaecal
  - Subcaecal
  - Retrocolic
- Appendix supplied by **appendicular artery**, which runs in the edge of the **mesoappendix**.



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- **Ascending colon**
  - Retroperitoneal
- **Right hepatic flexure**
- **Transverse colon**
  - Intraperitoneal
  - Hangs from transverse mesocolon
  - Usually hangs at least as low down as the umbilicus
- **Left splenic flexure**
  - Higher than hepatic flexure
- **Descending colon**
  - Retroperitoneal
  - Tethered laterally to diaphragm by **phrenicocolic fold**
  - Associated with diaphragm, spleen and lower pole of left kidney
- **Sigmoid colon**
  - Intraperitoneal
  - Begins at inlet to true pelvis
  - Long mesentery
- **Paracolic gutters:** space between lateral margins of ascending and descending colon, and the lateral abdominal walls.
- Right paracolic gutter runs into hepatorenal pouch
- Left paracolic gutter ends at phrenicocolic fold.

## BLOOD SUPPLY TO THE COLON:

- Border between midgut & hindgut is 2/3 of the way along the transverse colon.
- The blood supply changes here.

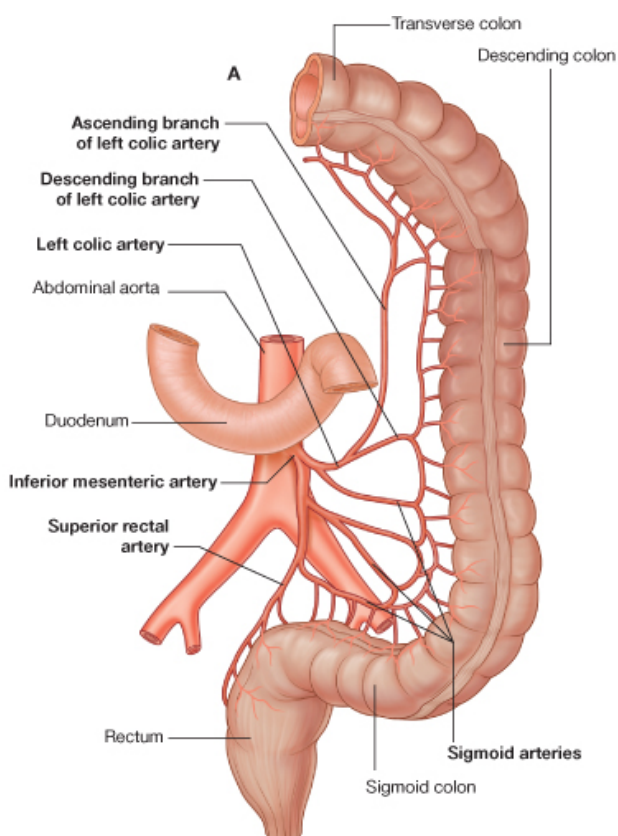
### **Ascending colon, and 2/3 of transverse colon – SUPERIOR MESENTERIC ARTERY**

- **Right colic artery** (approach is retroperitoneal, crosses right gonadal vessels and right ureter)
- **Middle colic artery** (enters transverse mesocolon close to lower border of pancreas)
- **Marginal artery (artery of Drummond)** – runs through transverse mesocolon and anastomoses with left colic artery

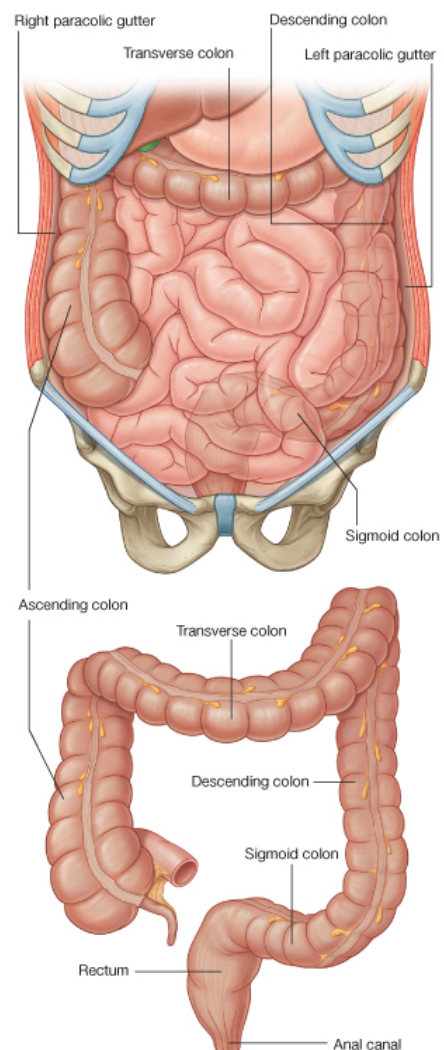
### **Distal 1/3 of transverse colon, descending colon, sigmoid colon, rectum – INFERIOR MESENTERIC A.**

- **Left colic artery** (retroperitoneal, running over left gonadal vessels and left ureter)
- **Sigmoid arteries**
- **Superior rectal artery** (supplies till anal canal above the **pectinate line**)

- The sigmoid colon gets its parasympathetic innervation from the pelvic splanchnic nerves



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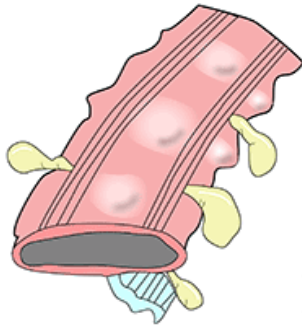


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## LARGE BOWEL - GENERAL

- Approximately 5 foot (1.4m)
- Partially retroperitoneal (see individual segments of bowel)
- Outer longitudinal muscle in three flat bands - Taenia Coli
- Taenia only in colon and caecum - not in rectum or appendix
- As taenia are shorter than the bowel they cause inner haustrations called Valvulae Conniventes
- Inner circular muscle
- Appendices epiploicae are little tags of fat at the mesentery border of the bowel - not in appendix, caecum or rectum
- Crypts with goblet cells but no villi
- Lymphatics: Alongside superior/inferior mesenteric vessels to para-aortics to coeliac and on upwards
- Nerves: Parasympathetic - vagus to 2/3 along transverse colon then S2,3,4 to rest of bowel. With sympathetics T10-L2 for vasoconstriction and pain. Note some pelvic organ pain is with parasympathetics



- Appendices epiploicae
- Taenia coli
- Sacculations
- Haustrations
- Mesentery

**THEY ALL STOP BEFORE  
THE RECTUM BEGINS**

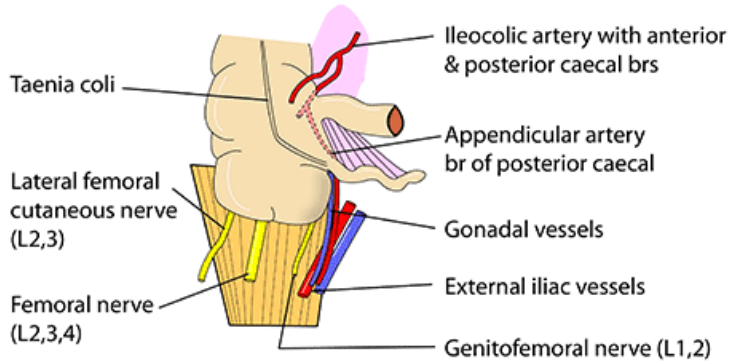
Note valvulae conniventes = small bowel, haustrations = large bowel

<b>Small bowel</b>	<b>Large bowel</b>
Central position	Peripheral position
Many loops	Few loops
<b>Complete rings</b> (valvulae conniventes)	<b>Incomplete rings</b> (haustrations)

## CAECUM AND APPENDIX

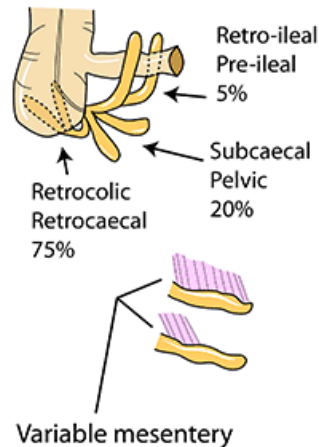
### CAECUM

- On mesentery
- Below ileocaecal valve
- Retrocaecal fossa behind it
- 3 taenia meet at base of appendix
- Ileocaecal valve is a double fold of mucosa & circular muscle of ileum which acts as an anti-reflux mechanism



### APPENDIX

- At McBurney's point
- 1/2"-9" (2-25cm) average 7-8cm
- Fully coated diverticulum
- Variable mesentery
- Appendicular artery usually from posterior caecal artery. It is an end artery hence appendix can easily become gangrenous
- Appendix moves posterior and medial with caecal expansion

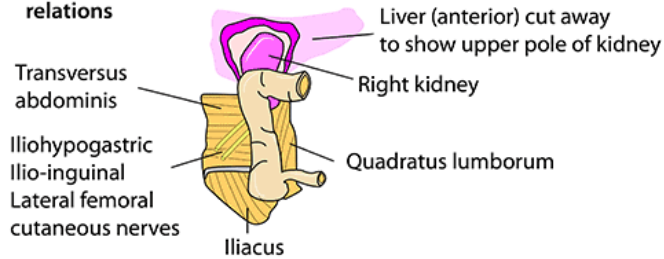


## ASCENDING AND TRANSVERSE COLON

### ASCENDING COLON

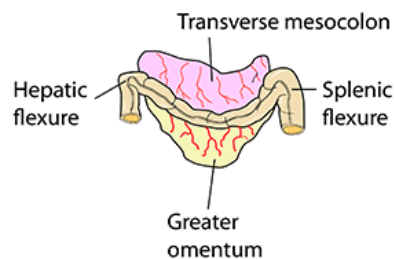
- 15cm (6")
- From ileocaecal valve to hepatic flexure
- Retroperitoneal
- Anterior: Coils of small bowel & omentum

#### Posterior relations

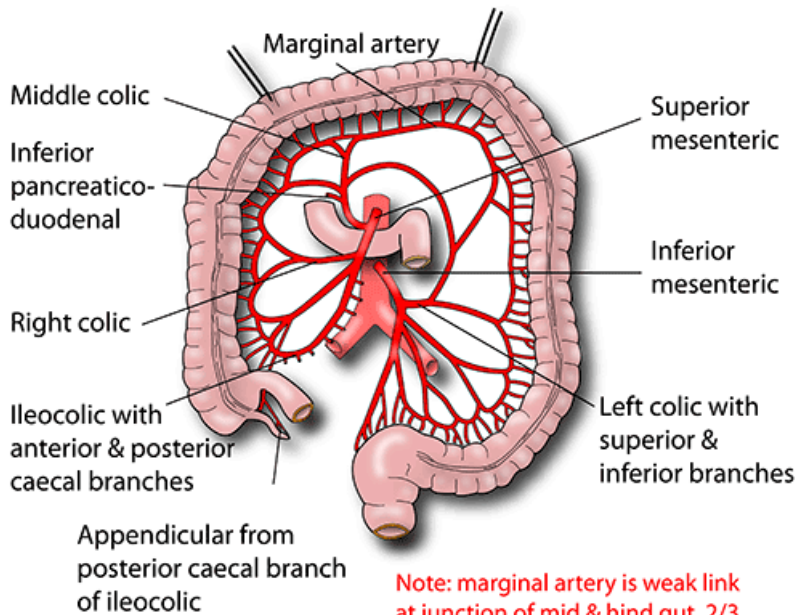


### TRANSVERSE COLON

- 45cm (18")
- Between hepatic and splenic flexures
- Fixed at both ends
- Hangs on transverse mesocolon



## SUPERIOR & INFERIOR MESENTERIC ARTERIES



Note: marginal artery is weak link at junction of mid & hind gut, 2/3 along transverse colon

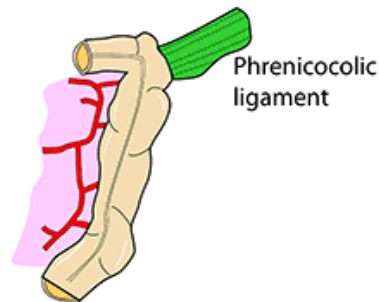
## DESCENDING AND SIGMOID COLON

### DESCENDING COLON

- 30cm (9-12")
- From splenic flexure to brim of pelvis
- Retroperitoneal
- Appendices epiploicae ++
- Lies on psoas, iliacus, transversus abdominis, quadratus lumborum

#### Posterior relations

- Left subcostal artery/vein/nerve
- Iliohypogastric nerve
- Ilio-inguinal nerve
- Lateral femoral cutaneous nerve
- Genitofemoral nerve
- Gonadal artery/vein
- External iliac artery/vein

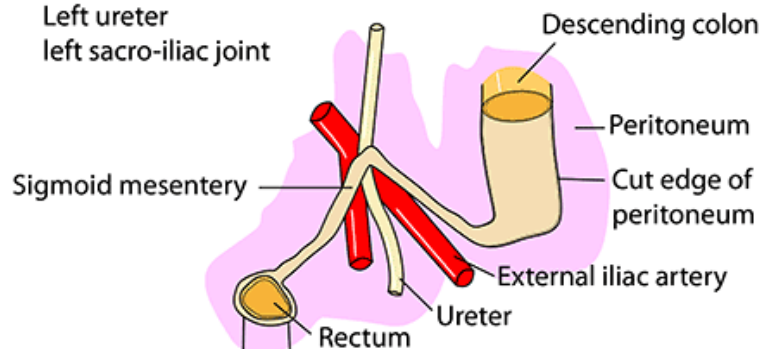


### SIGMOID COLON

- 15-45cm (5-30")
- From pelvic brim to S3 midline
- On mesentery
- Appendices epiploicae +++
- Taenia become progressively more as a longitudinal coat

Sigmoid colon is excised to expose the base of its mesentery which crosses:

- Common iliac artery bifurcation
- Left ureter
- left sacro-iliac joint



### RECTUM:

- Follows sacral flexure

#### Upper 1/3

- Peritoneum on front and sides

#### Middle 1/3

- Peritoneum only on anterior surface

#### Last 1/3

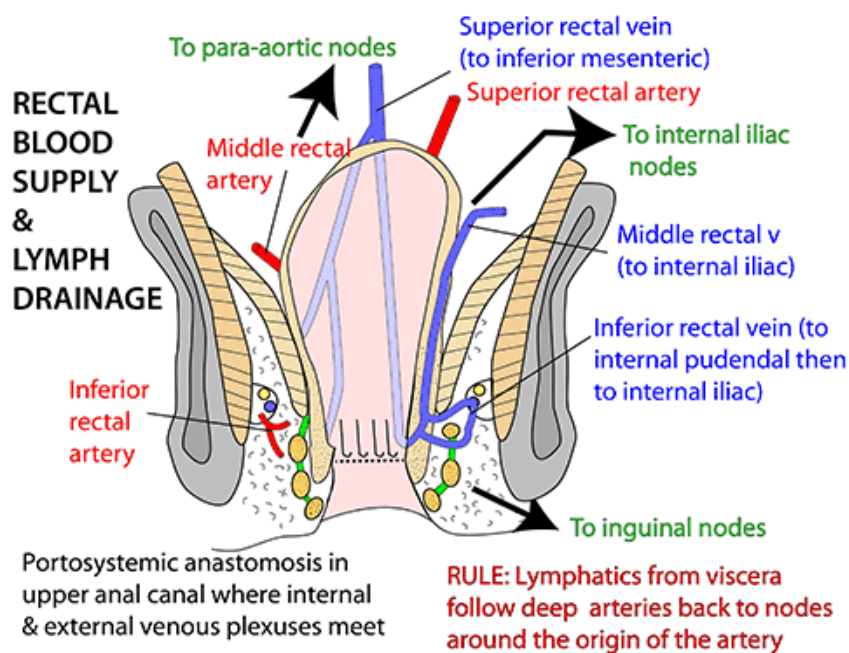
- No peritoneal covering – because peritoneum is reflected onto bladder (M) / vagina (F)

## RECTUM - VESSELS/LYMPHATICS

Blood supply: Superior rectal artery from inferior mesenteric  
 Middle rectal artery from internal iliac.  
 Smaller inferior rectal artery from internal pudendal  
 Median sacral may contribute  
 All arteries supply all layers

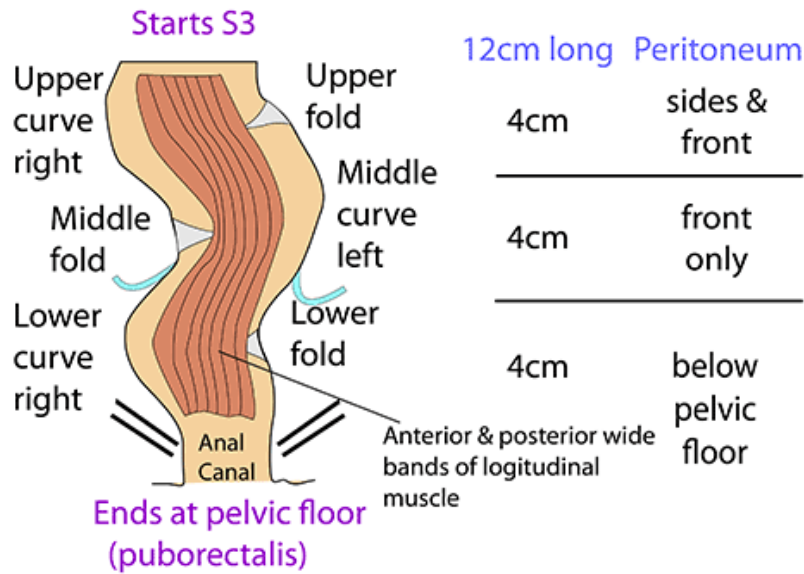
Venous drainage: Superior rectal vein to inferior mesenteric which is portal. Middle rectal to internal iliac (systemic)  
 Inferior rectal to internal pudendal to internal iliac (systemic). Portosystemic anastomosis in upper anal canal where internal & external venous plexuses meet.

Lymphatics: Follow deep veins and arteries (black arrows below)



Lower anus (below pectinate line) tends to drain to the inguinal nodes

## RECTUM (length & peritoneal covering)



## RECTUM DETAILS

No appendices epiploicae, no sacculations, no mesentery

**Nerves:**

**Sympathetic** - contract smooth muscle sphincters, relax bowel, transmit pain

**Parasympathetic** - Relax smooth muscle sphincters, contract bowel, transmit feeling of fullness

Folds are mucosa & circular muscle = valves of Houston

The rectum is normally empty but fills before and during defaecation

**Upper 2/3** is distensible into abdominal cavity & may store faeces in constipation

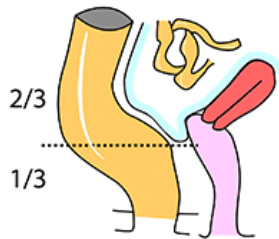
**Lower 1/3** normally but can distend laterally into the ischio-anal fossa

Note: **longitudinal muscle** is two wide bands anteriorly & posteriorly that become fibrous within the sphincters. **Circular muscle** complete but thickened below as internal sphincter

**Rectum starts at S3**

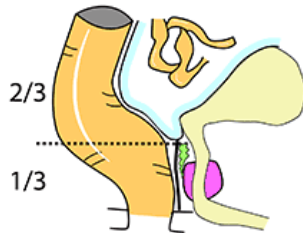
## RECTUM - RELATIONS

### ANTERIOR



#### Female

- Recto-uterine pouch (of Douglas)
- Small bowel
- Vagina (posterior fornix)
- Uterus & bladder



#### Male

- Rectovesical pouch
- Small bowel
- Denonvillier's fascia
- Bladder
- Vas, seminal vesicle
- Prostate

### POSTERIOR

Fascia, median sacral & rectal vessels, sympathetic trunk, pelvic splanchnic nerves, piriformis, sacral & coccygeal roots, sacrum, coccyx, anococcygeal body

### LATERAL

Peritoneum, fat, nodes, obturator internus & its fascia, Alcock's canal & contents, levator ani & coccygeus, ischio-anal fossa, lateral (fascial) ligaments of rectum

**Denonvillier's fascia is probably a double layer of peritoneum acting as a major factor in preventing the spread of cancer in either direction**

### ANAL CANAL:

- Starts where bowel begins to pass through floor of pelvis.
- **Puborectalis muscle** – pulls proximal part of anal canal forward
- Terminal branches of superior rectal arteries fold mucosa – longitudinal **anal columns**
- Base of anal columns – crescentic folds called **anal valves**
- Anal valves form the **pectinate line**
- **Internal rectal venous plexus** – beneath mucosa of anal columns (venous drainage above the pectinate line)

### BLOOD SUPPLY TO THE RECTUM AND ANUS:

#### RECTUM:

##### Arterial:

*Above pectinate line:*

- Superior rectal arteries (from inferior mesenteric)

*Below pectinate line:*

- Inferior rectal arteries (branches of internal pudendal arteries)

*Muscle layers of rectum:*

- Middle rectal arteries (from internal iliac)

**Venous:**

*Above pectinate line:*

- **Internal venous plexus** → **superior rectal veins** → inferior mesenteric vein → splenic vein → portal vein.

*Below pectinate line:*

- **External venous plexus** → **inferior rectal veins** → internal pudendal veins → internal iliac veins

*Muscle layers of rectum:*

- Middle rectal veins → internal iliac vein
- **Haemorrhoids (piles)** = prolonged distension of rectal veins (prone because no valves in inferior mesenteric vein). Occur at 3, 7, 11 o'clock as if the anus was a clock-face.

**Anal sphincters:**

- 2 sets of anal sphincters

*Internal anal sphincter:*

- Thickened distal circular smooth muscle
- Involuntary autonomic control

*External anal sphincter:*

- Composed of 3 groups of circular smooth muscle
- **Subcutaneous:**
  - No bony attachment
- **Superficial:**
  - Coccyx posteriorly → perineal body anteriorly
  - Has bony attachment
- **Deep part:**
  - Encircles upper part of anal canal
  - No bony attachment
- **Intersphincteric line** = can be palpated; marks junction between subcutaneous and superficial external anal sphincter.

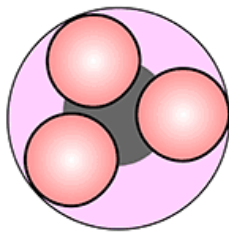
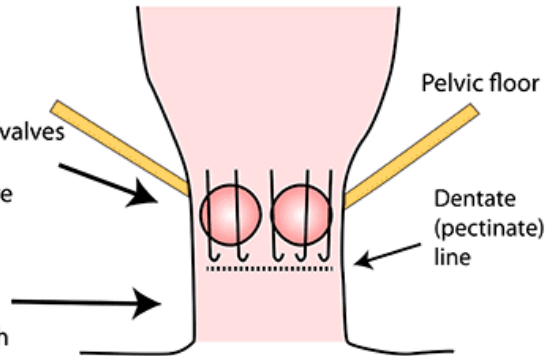


## ANAL CANAL - GENERAL

- 4cm long, from pelvic floor (puborectalis) to outside
- Two distinct halves of 2cm separated by dentate (pectinate) line

- **Upper half** (2cm)
- 12 anal columns/valves
- 3 cushions
- Largely insensitive to touch

- **Lower half** (2cm)
- Skin
- Sensitive to touch



3 spongy muscosal cushions are in the upper half, at 3, 7 & 11 o'clock. They contain bright red capillary blood.

They help with continence, air tightness & mucus production.

Enlargement leads to haemorrhoids (piles).

**NOTE:** Although they are at the same level as the venous plexuses (which can enlarge in a portosystemic anastomosis) they are quite separate from them

### UPPER HALF

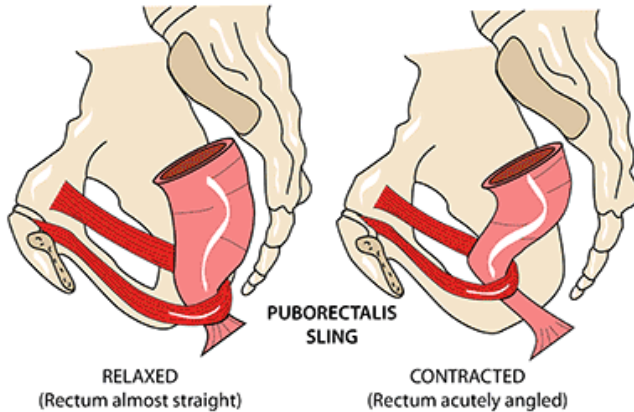
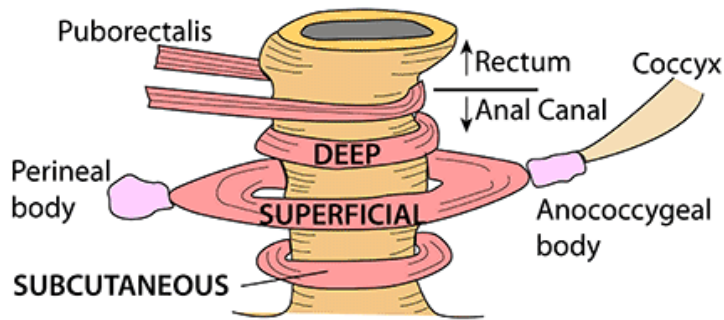
- Endoderm origin
- Columnar mucosa
- Columns, valves & cushions
- Autonomic nerves
- Mainly superior rectal artery
- Portal venous drainage
- Para-aortic lymph nodes
- Adenocarcinoma
- Site of haemorrhoids

### LOWER HALF

- Ectoderm origin
- Squamous mucosa
- Skin
- Somatic nerves
- Mainly inferior rectal artery
- Systemic venous drainage
- Superficial inguinal nodes
- Squamous carcinoma
- No haemorrhoids

**Anocutaneous reflex:** Touching the skin near the anus (S2,3,4) gives a reflex contraction of the external anal sphincters

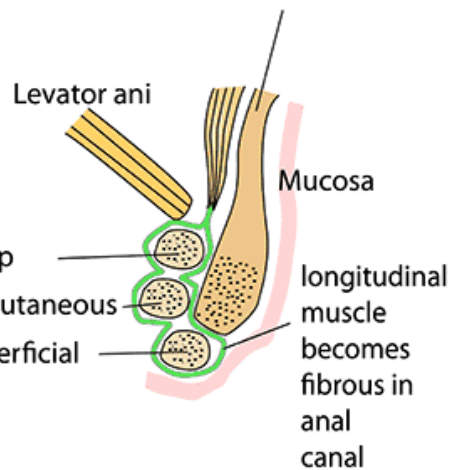
## ANAL CANAL - SPHINCTERS



Circular muscle becomes the “involuntary internal anal sphincter” which relaxes with moderate pressure from above

Part of the “voluntary external anal sphincter” that reflexly or voluntarily relax with high pressure from above

### INTERNAL & EXTERNAL ANAL SPHINCTERS



### CONTINENCE

- Internal sphincter (involuntary)
- External sphincter (voluntary)
- Recto-anal angle (puborectalis)
- Anal cushions & mucosal folds
- Abdominal pressure on upper anterior part of lower rectum

### NOTE:

Incontinence can be due to overflow around impacted faeces in constipation

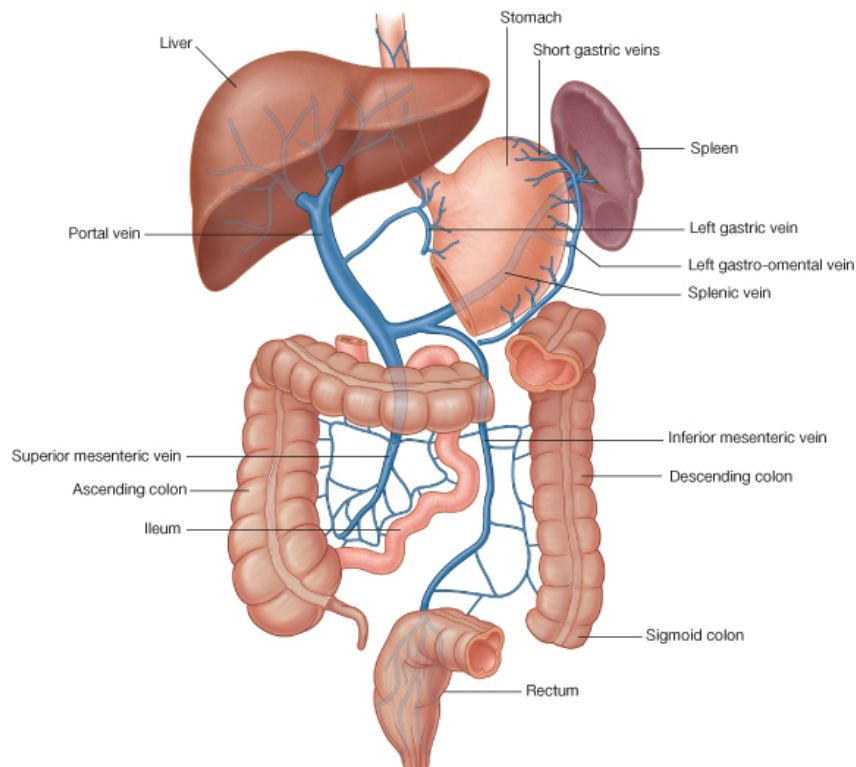
### NERVE SUPPLY TO THE ANUS:

- Below pectinate line – external anal sphincter and mucosa
  - **Inferior rectal branch of the pudendal nerve - somatic**
  - V. sensitive

- Above pectinate line – internal anal sphincter and mucosa
  - Autonomic plexus
  - Symp – contracts internal sphincter
  - Parasymp – relaxes sphincter
  - Only sensitive to stretch – distension activates defecation reflex.

#### PORTAL VEIN:

- Drains whole GI tract
- 3 main components:
  - Splenic vein
  - Superior mesenteric vein
  - Inferior mesenteric vein (runs into splenic vein)
- several smaller tributaries:
  - L & R gastric veins
  - Cystic vein (gall bladder)
- Behind pancreas, splenic & S.M vein fuse
- **Passes through free margin of lesser omentum** to porta hepatis of liver



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#### NERVE SUPPLY OF THE ABDOMINAL VISCERA

##### Autonomic Nervous Supply

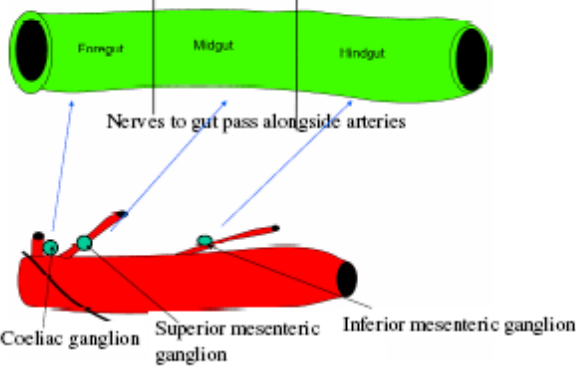
- The **sympathetic** supply includes:
  - Greater splanchnic nerve (T5-9)
  - Lesser splanchnic nerve (T9-10)
  - Lowest (least) splanchnic nerve (T12)

- Lumbar splanchnic nerves (L1-3)
  - Sacral splanchnic nerves
- The **parasympathetic** supply includes:
    - Vagus nerve:
      - Right vagus → posterior oesophageal plexus (lower 1/3) → posterior gastric nerve (becomes a major part of the coeliac plexus)
      - Left vagus → anterior oesophageal plexus → anterior gastric nerve (supplies mainly the stomach)
    - Pelvic splanchnic nerve - S2, S3, S4
  - These form the **pre-aortic plexus**, which are situated anterior to the aorta and vertebral column
  - Preaortic plexus consists of:
    - **Coeliac Plexus**
    - At the level of the last thoracic and 1st lumbar vertebra.
    - It surrounds the root of the coeliac trunk and the superior mesenteric artery.
    - Supplies the foregut (oesophagus, stomach and first ½ of duodenum)
    - Sends nerves down to the SM plexus and IM plexus
    - **Superior Mesenteric Plexus**
    - This is a downward extension of the coeliac plexus.
    - It accompanies the superior mesenteric artery to the midgut:
      - pancreas
      - 2<sup>nd</sup> ½ of duodenum
      - Jejunum
      - Ileum
      - Large intestine (until 2/3 of way along transverse colon)
    - **Inferior Mesenteric Plexus**
    - This receives supply from the aortic plexus and 2nd and 3rd lumbar splanchnic nerves.
    - Supplies the hindgut (from 2/3 along transverse colon →)
  - The **hypogastric nerves** carry sympathetic fibres and visceral afferent fibres to the pelvic viscera (e.g. ductus deferens)

#### **SPLANCHNIC NERVES:**

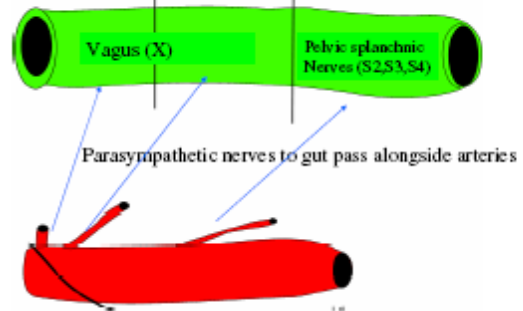
- Note;
- Thoracic and lumbar (& sacral) splanchnic nerves are **sympathetic**
- The pelvic splanchnic nerves are **parasympathetic**
- **Visceral afferent fibres** travel through the **splanchnic nerves**
- **Pain tends to travel with sympathetic splanchnic nerves**

Postganglionic sympathetic fibres arise from the pre-aortic plexus

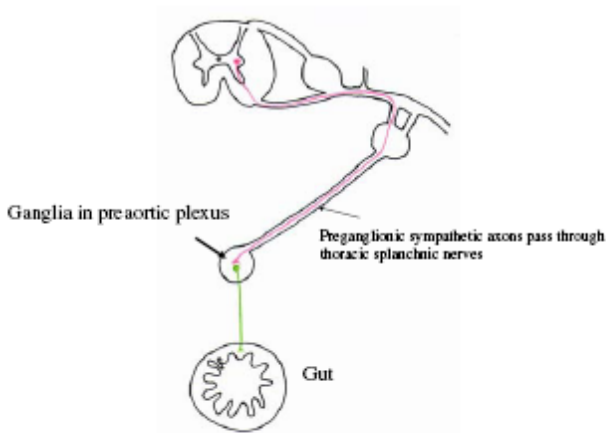


Sympathetic neurons are found in ganglia at the base of arteries

Parasympathetic fibres are distributed through the pre-aortic plexus



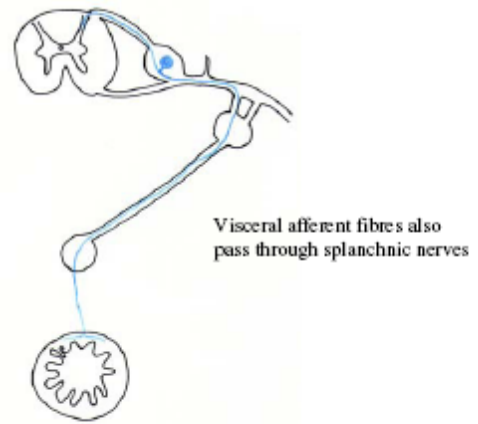
Preganglionic parasympathetic fibres are derived from the vagus and pelvic splanchnic nerves- they synapse in ganglia in the wall of the gut (enteric plexuses)



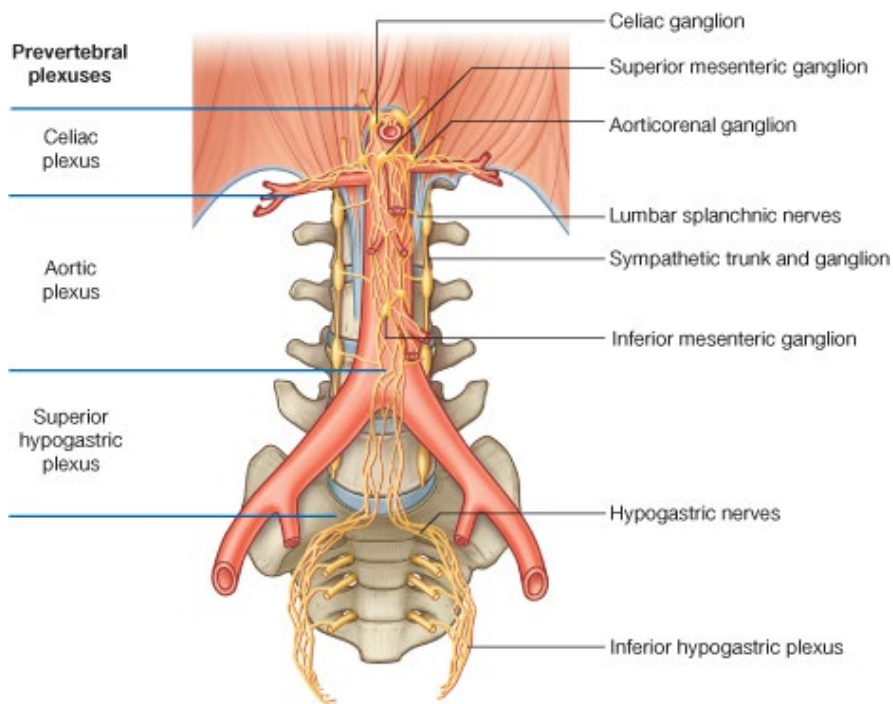
Ganglia in pre-aortic plexus

Preganglionic sympathetic axons pass through thoracic splanchnic nerves

Gut



Visceral afferent fibres also pass through splanchnic nerves



REFERRED PAIN IN ABDOMEN:

- Pain from visceral structures is afferent via sympathetic splanchnic nerves to the spinal cord, then radiates out from the same segment of the spinal cord into which the visceral afferent fibres run (to the furthest dermatome at that level)

*Stomach:*

- Afferents → T7 & T8 (with sympathetic nerves in greater splanchnic)
- Referred pain → dermatome T6 & T7, just below sternum

*Appendix:*

Early:

- Afferents → T10
- Referred pain → dermatome T10, the umbilicus

Late:

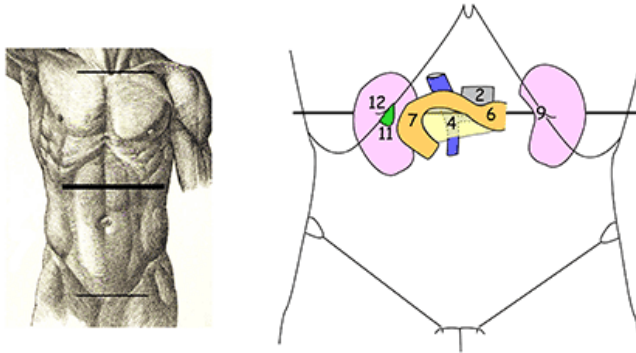
- Peritoneum over appendix in R. Iliac is irritated
- Parietal peritoneum supplied by somatosensory neurones – v. sensitive (esp to stretch)
- → late pain is localised to appendix.
- **Rebound tenderness** (recoiling of peritoneum after pressing it) is v. painful.

*Ureters:*

- Afferents → T12 & L1
- Referred pain → dermatomes T12 & L1 (in back between ribs and iliac crest, radiating down to inguinal canal and scrotum) – i.e. **loin and groin**
- Stones in ureters

## TRANSPYLORIC PLANE

(Horizontal line half way between suprasternal notch & pubic symphysis)

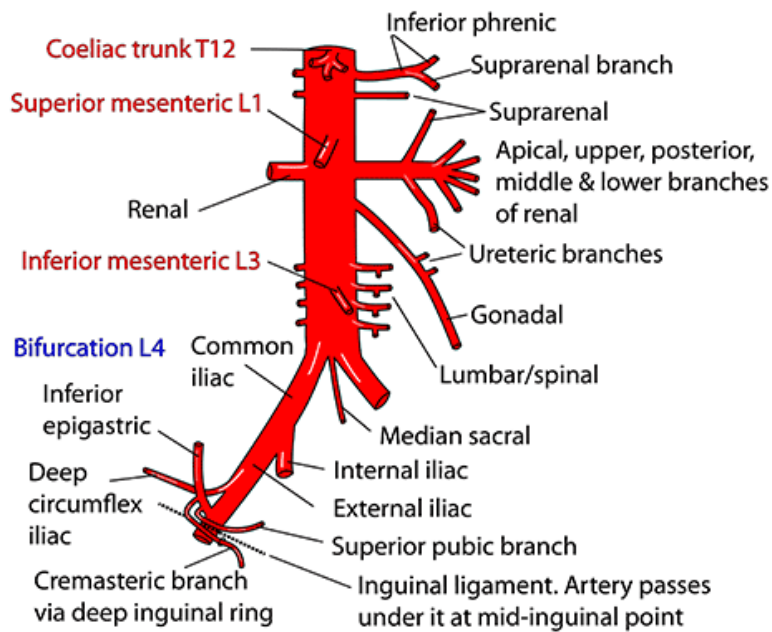


Structures approximately on this line:

- 1 End of spinal cord
- 2 L1 vertebral body
- 3 Origin of superior mesenteric art
- 4 Origin of portal vein
- 5 Neck of pancreas
- 6 Pylorus of the stomach
- 7 Second part of duodenum
- 8 Sphincter of Oddi
- 9 Hilum of each kidney
- 10 Duodenojejunal flexure
- 11 Fundus of gall bladder
- 12 Tips of ninth costal cartilages

**ABDOMINAL AORTA:**

## ABDOMINAL AORTA AND RIGHT EXTERNAL ILIAC ARTERY



### Relations of aorta

**Left lateral:** Sympathetic chain

**Right lateral:** IVC, Cisterna chyli

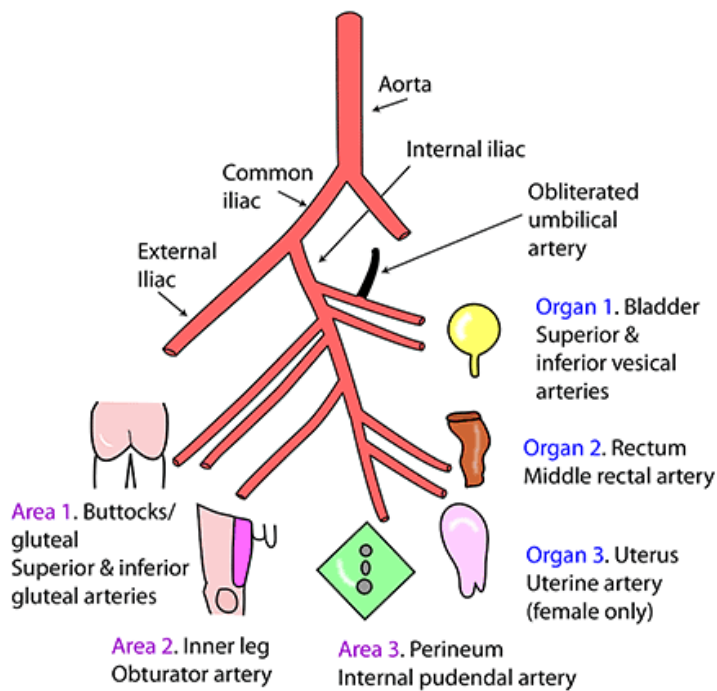
**Both lateral:** Azygos veins, para-aortic nodes, coeliac ganglia

**Anterior:** Pancreas, splenic vein, left renal vein, 3rd part duodenum, mesentery, nodes, autonomic plexus, lesser sac, stomach, omentum, small bowel

**Posterior:** T12-L4 vertebrae, left lumbar veins



## BRANCHES OF THE INTERNAL ILIAC ARTERY



A simple representational diagram of the branches of the internal iliac artery. An easy way to remember them is to think of them in 2 groups, each with 3 branches. **Group 1** has 3 branches to organs (bladder, rectum and uterus) and **Group 2** has 3 branches to areas (buttocks/gluteal, adductor compartment and perineum).

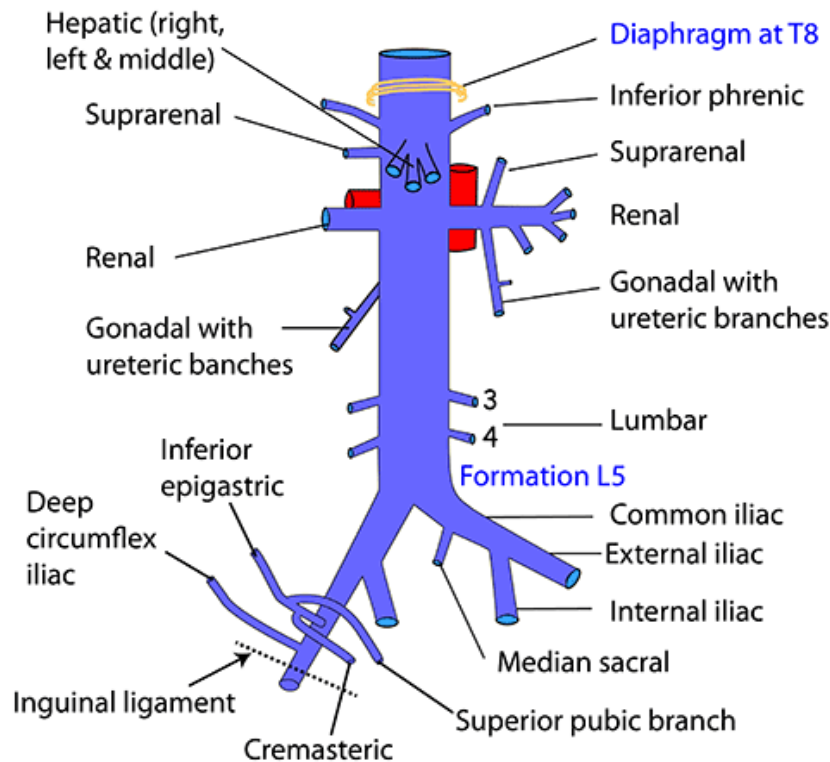
**ILIOLUMBAR**: Passes laterally, behind obturator nerve & psoas. Lumbar branch to psoas, quadratus lumborum & spine. Iliac branch to iliacus, iliac bone, anastomosis at anterior superior iliac spine

**LATERAL SACRAL**: Passes inferiorly, lateral to anterior sacral foramina & anterior to nerve roots & piriformis

**ARTERY TO VAS**: Usually off superior vesical (or inferior vesical)

**UTERINE ARTERY**: In female it largely replaces middle rectal (or inferior vesical)

## INFERIOR VENA CAVA



### Relations of IVC

**Anterior:** Bile duct, liver, opening of lesser sac, 1st/3rd parts of duodenum, head of pancreas, small bowel, right common iliac artery, root of mesentery, right gonadal artery, portal vein

**Posterior:** Right renal artery, lumbar arteries, right crus of diaphragm, right suprarenal & its artery, bodies of L3,4,5 vertebrae, right psoas, right sympathetic chain, right coeliac ganglion

**Note:** NO tributaries from gut

Left gonadal + left adrenal vein join the L renal vein

The corresponding veins on the R side join the IVC directly

### INGUINAL CANAL

## INGUINAL CANAL

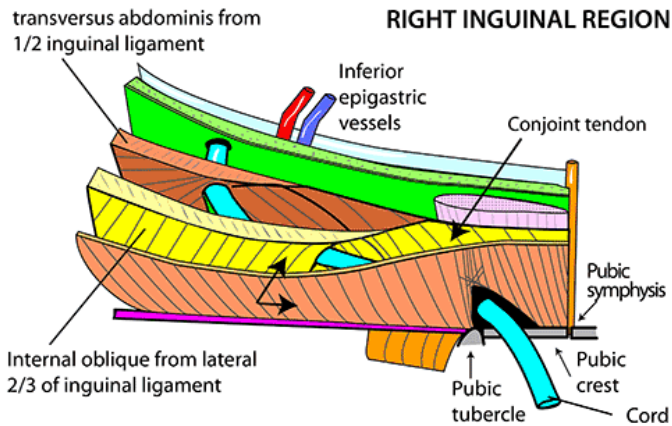
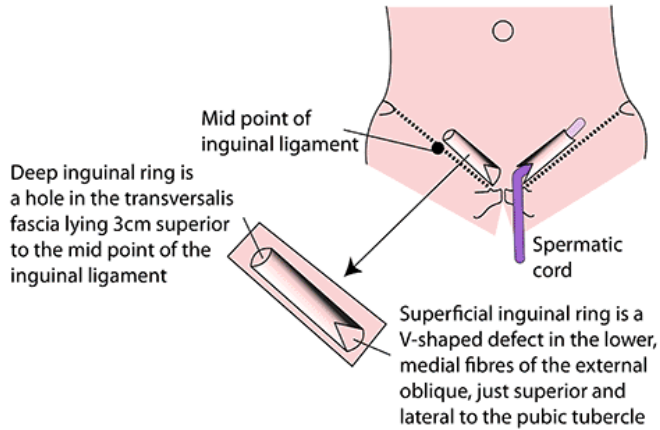
A 4cm tunnel in the lower, anterior abdominal muscles that runs downwards and medially between the deep and superficial inguinal rings

Anterior wall: external oblique, & internal oblique for lateral 1/3

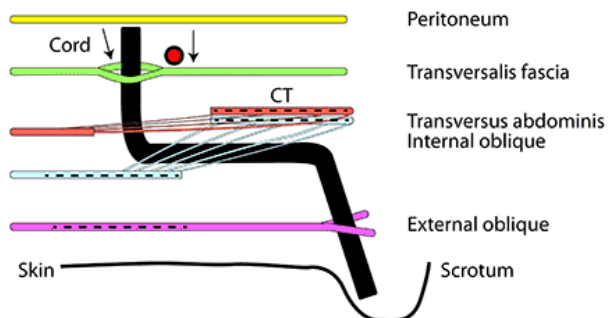
Roof: Arching fibres of internal oblique & transversus

Posterior wall: transversalis fascia & conjoint tendon

Floor: inguinal ligament



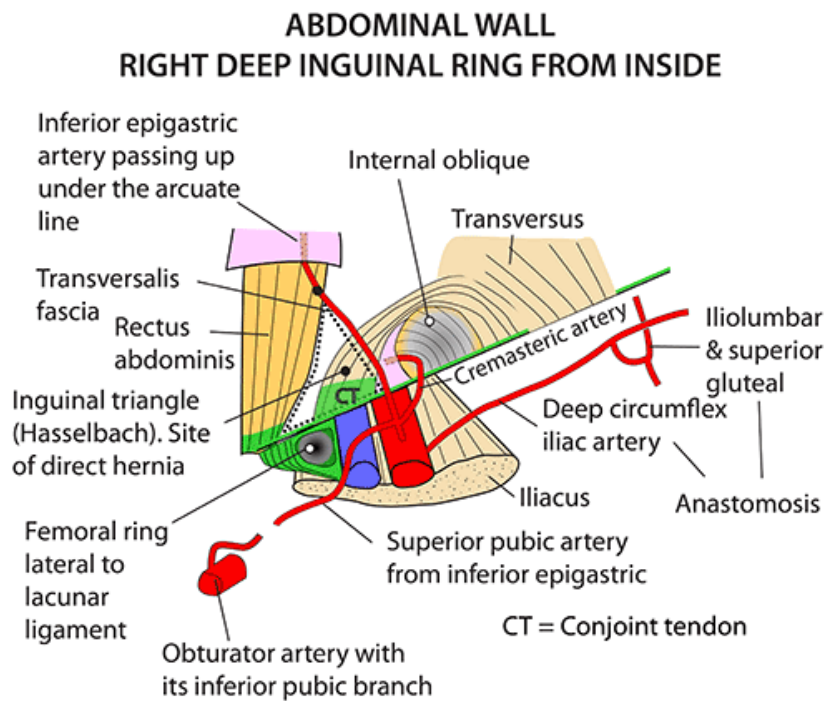
Arrows show 2 areas of "reinforcement" for superficial and deep ring



### EXPLODED INGUINAL CANAL

- Arrows indicate sites of weakness at deep ring (indirect hernia) and at transversalis fascia lateral to conjoint tendon (direct hernia).
- Dotted lines indicate the 2 layers that support both the deep and superficial inguinal rings.

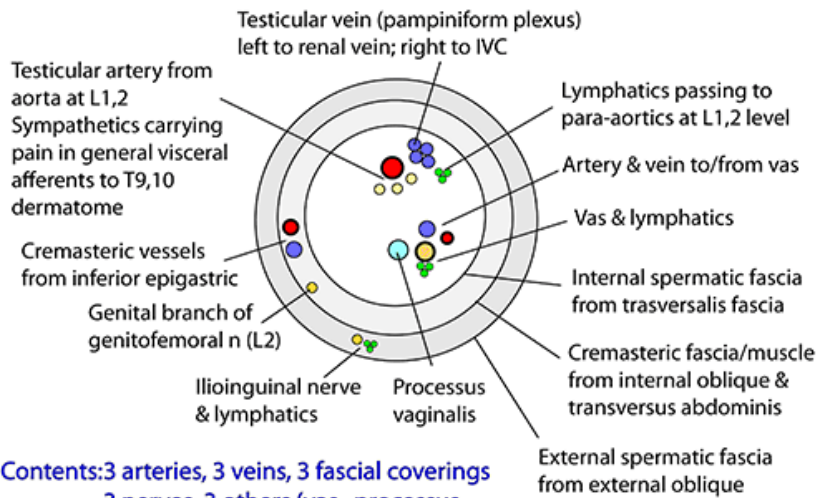
Conjoint tendon is the insertion of the common aponeurosis of internal oblique + transversus abdominus into the pubic crest.



**Note:** If the obturator artery is missing then the superior pubic branch of the inferior epigastric takes over. This artery is then called an abnormal (aberrant) obturator artery. Whether or not an abnormal obturator artery is present, the superior pubic branch of the inferior epigastric may run antero-medial to the sac of a femoral hernia in the femoral ring. If so, it can easily be damaged during a hernia repair. In this illustration it runs posterolateral and is thus not a hazard

## SPERMATIC CORD

(Cross section just beyond external inguinal ring)



### VIA THE DEEP INGUINAL RING

- Vas
- Artery to vas (inferior vesical)
- Testicular artery (aorta)
- Cremasteric artery (inferior epigastric)
- Cremasteric vein (inferior epigastric)
- Testicular vein (IVC/left renal)
- Obliterated processus vaginalis
- Lymphatics
- Sympathetics
- Genital branch of genitofemoral n (L2)  
Supplies motor to cremaster, sensory to fascia, tunica, scrotal skin, round ligament & labia majus

### IN CANAL

- All these plus
- Internal spermatic fascia
- Cremasteric fascia
- Cremaster muscle
- Ilio-inguinal nerve

### OUTSIDE SUPERFICIAL RING

- All these plus
- External spermatic fascia from external oblique

### 3 arteries:

- Artery to vas deferens (inferior vesical – internal iliac)
- Testicular artery (aorta)
- Cremasteric artery (inferior epigastric – external iliac)

### 3 veins:

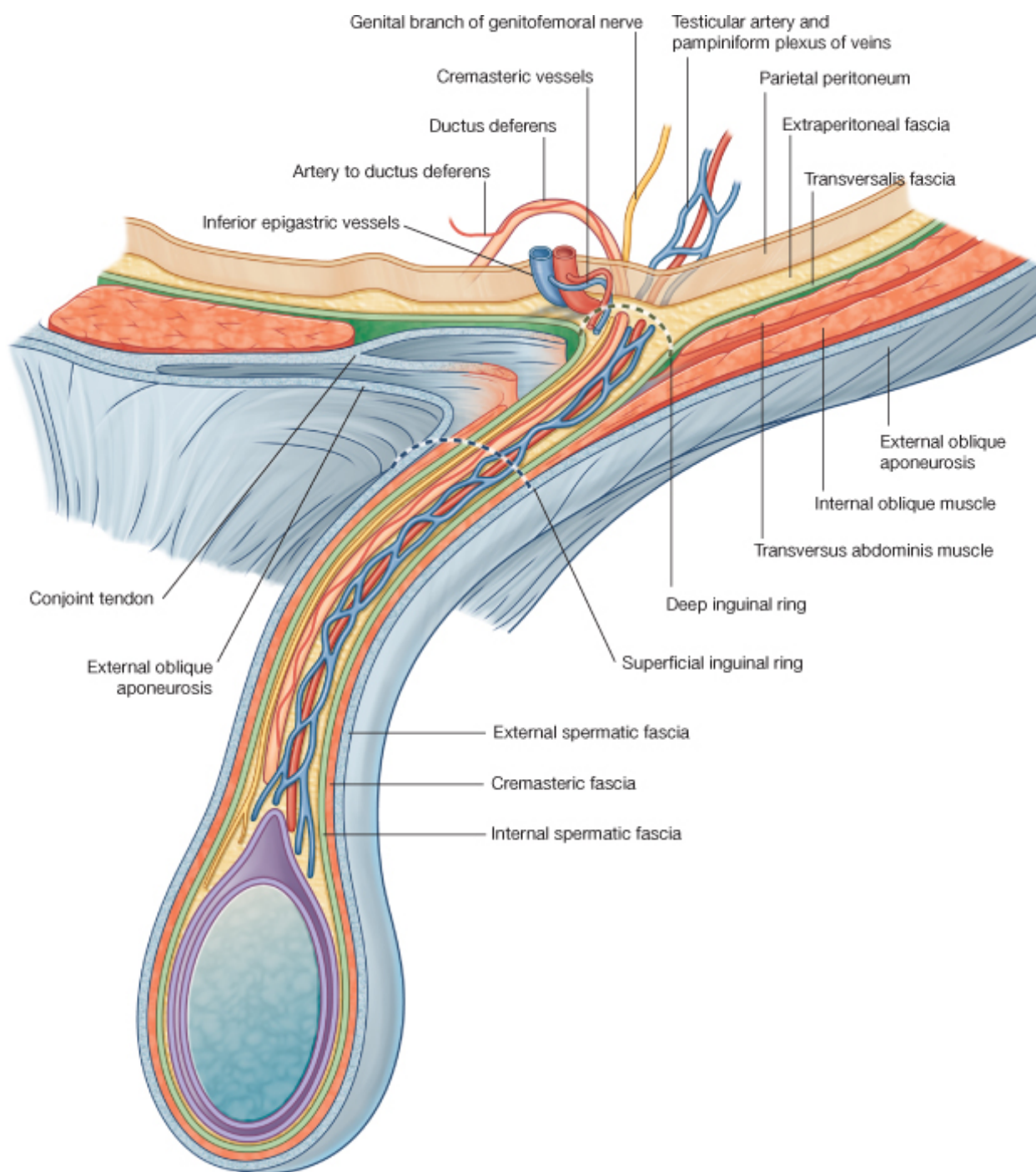
- Vein from vas deferens
- Testicular vein – pampiniform plexus (IVC / L renal)
- Cremasteric vein

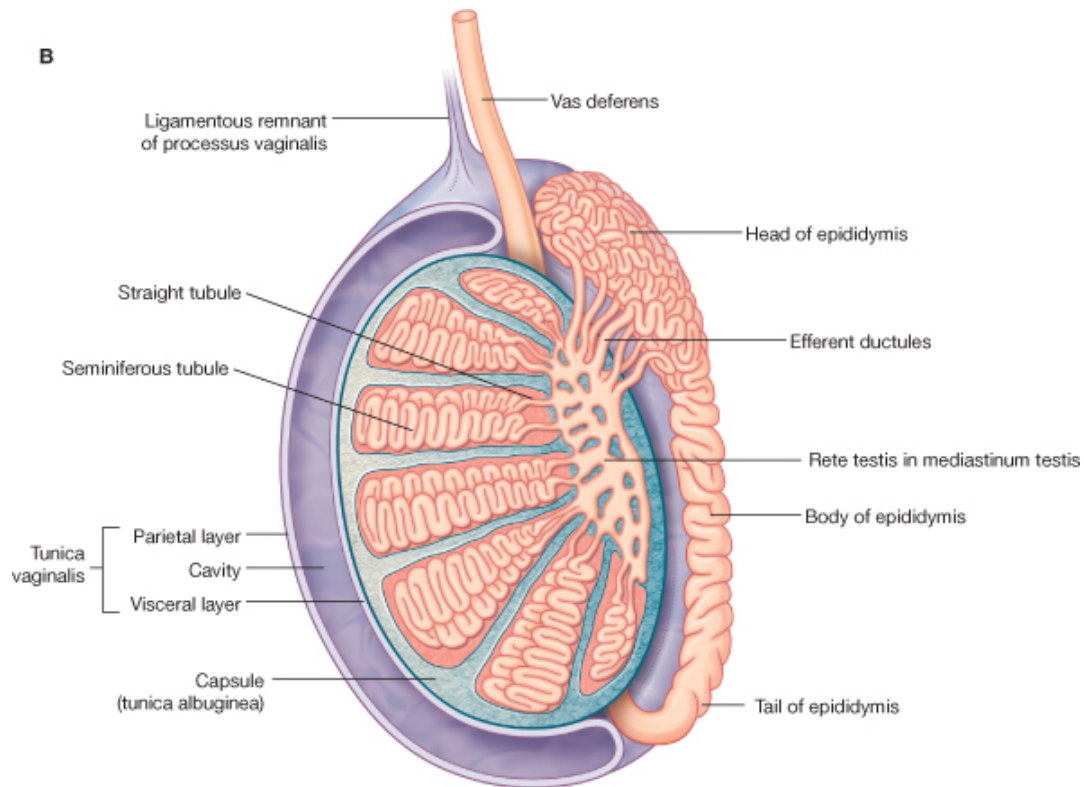
### 3 nerves:

- Ilioinguinal nerve (sensation, doesn't enter through deep ring)
- Genital branch of genitofemoral (supplies cremaster)
- Sympathetics

### 3 others:

- Vas deferens
- Processus vaginalis
- Lymphatics



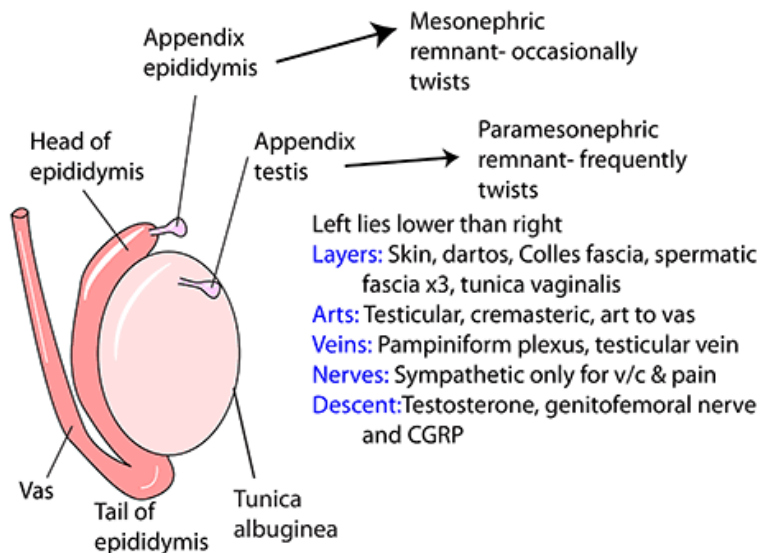


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Whole testicle surrounded by 3 layers of fascia which surrounds the cord – internal, cremastic, external spermatic fascia.

## TESTIS

- 400 spaces divided by fibrous septa
- Each contains 2-4 convoluted seminiferous tubules
- Tubules are 60cm long & drain to 15-20 vasa efferentia which drain to the epididymis and then to vas deferens
- Complete cycle of production takes 64-70 days
- Left testis lies slight lower than right
- Coverings: Skin, dartos (with sympathetic supply), Colles fascia, external spermatic fascia, cremasteric fascia, internal spermatic fascia, tunica vaginalis
- Blood supply: Testicular artery, cremasteric/vas artery
- Venous drainage: Pampiniform plexus to testicular vein
- Lymph: Para-aortic nodes
- Nerve: Sympathetics from chain at L2 for vasoconstriction & carrying general visceral afferents for pain to T10 dermatome.  
**NO parasympathetics!**
- Cells: Interstitial (Leydig) for hormones  
Sertoli for support and Mullerian Inhibiting Substance  
Germ cells for spermatogonia, primary spermatocytes, meiosis, secondary spermatocytes, spermatids, sperm



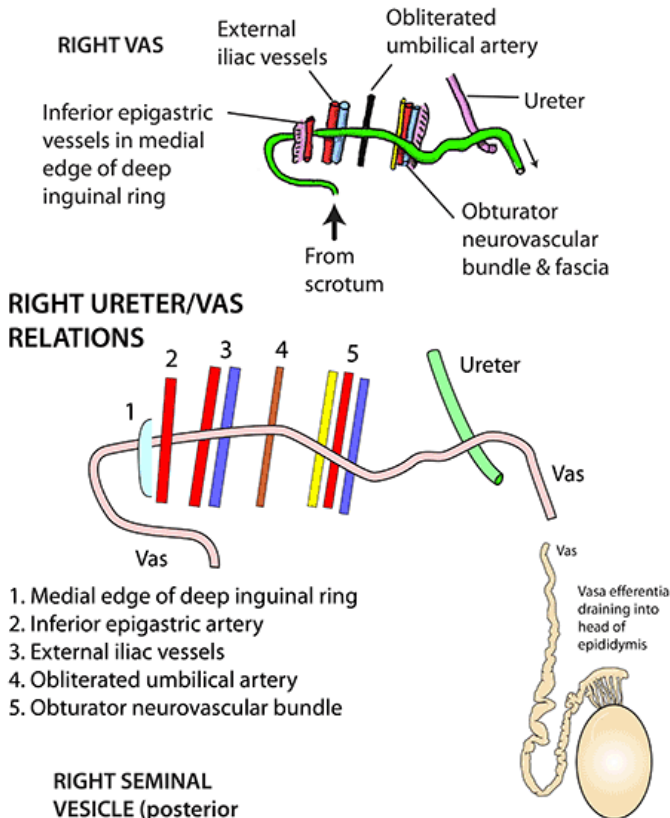
Cervix only has parasympathetics

Testes has no parasympathetics

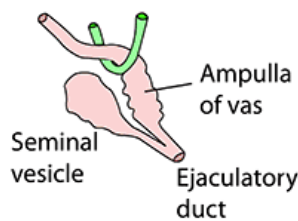


## VAS & SEMINAL VESICLE

The ductus (vas) deferens is about 45cm long (as is femur, thoracic duct, spinal cord, Transverse colon & teeth to cardia of stomach!!) and is a highly muscular (smooth muscle) tube with ciliated epithelium. It starts at the lower pole of the epididymis and ends at the ejaculatory duct. It lies just beneath the peritoneum for most of its intra-abdominal course. It is supplied by a branch of either the superior or inferior vesical artery. Motor activity during ejaculation is controlled by post-ganglionic sympathetic fibres. Originates from the mesonephric duct



### RIGHT SEMINAL VESICLE (posterior view)



- 70% of ejaculate
- Does not hold sperm
- Thin walled sac
- Covered by Denonvillier's fascia
- Artery: Vesical and middle rectal
- Origin: Mesonephric duct
- Nerve: Sympathetic from L1
- Muscle: Outer longitudinal, inner circular

Seminal vesicles are thin walled sacs lying posterior to the bladder and prostate, producing 70% of the ejaculate but **containing NO sperm**. The remaining 30% is produced by the prostate. They produce fructose with medicolegal importance in identifying seminal fluid. They are covered posteriorly by Denonvillier's fascia. Arterial supply is from the vesical or middle rectal arteries and nerve supply is post-ganglionic sympathetic fibres. They arise from the mesonephric ducts. The lining is outer longitudinal and inner circular smooth muscle - needed for ejaculation. The ejaculatory ducts are formed by the distal vas and the seminal vesicle duct and enter the posterior urethra at the verumontanum.

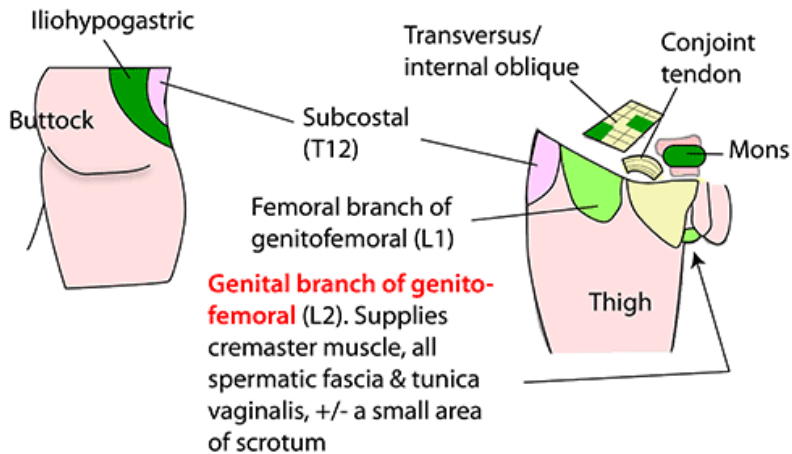
## ILIOHYPOGASTRIC, ILIO-INGUINAL & GENITOFEMORAL NERVES

### ILIOHYPOGASTRIC NERVE

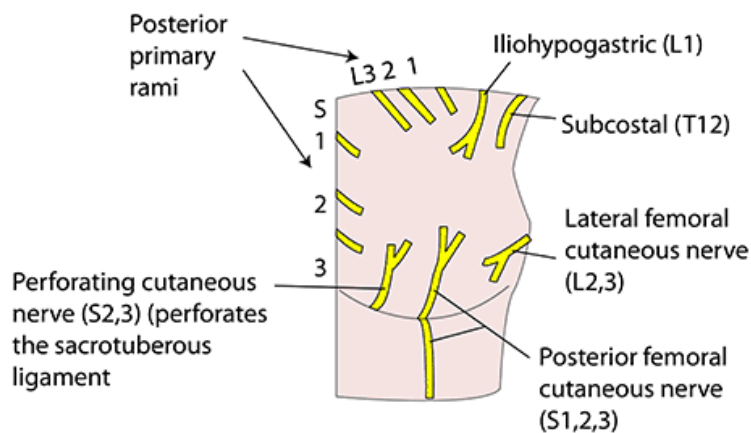
- Main branch of L1
- Sensory and motor
- Pierces internal oblique above anterior superior iliac spine
- Pierces external oblique above superficial inguinal ring
- Supplies:
  - Upper buttock (lateral cutaneous branch)
  - Transversus & internal oblique (lowest fibres)
  - Skin of mons pubis

### ILIOINGUINAL NERVE

- Muscular collateral branch of L1
- Motor and sensory
- Pierces internal oblique above anterior superior iliac spine
- Supplies:
  - Transversus & internal oblique (lowest fibres)
  - Conjoint tendon
- Then enters inguinal canal from above/lateral and leaves via superficial inguinal ring
- Supplies:
  - Upper medial thigh, anterior 1/3 scrotum, labia majora and root of penis



### CUTANEOUS NERVE SUPPLY OF BUTTOCKS

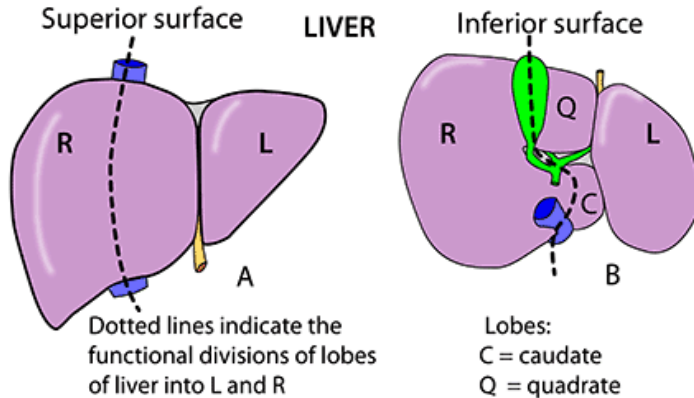


Note that the POSTERIOR RAMI of C1, L4,5, S4,5 and the coccygeal nerves do not reach the skin

**LIVER:**

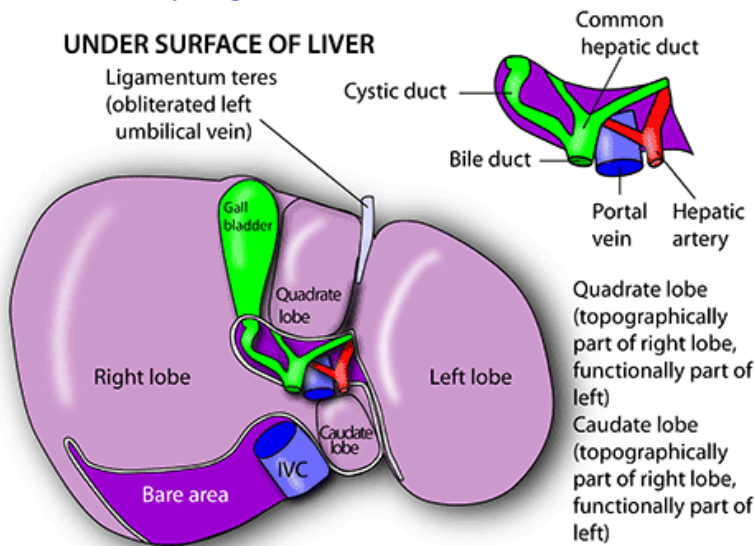
**LIVER - GENERAL DESCRIPTION**

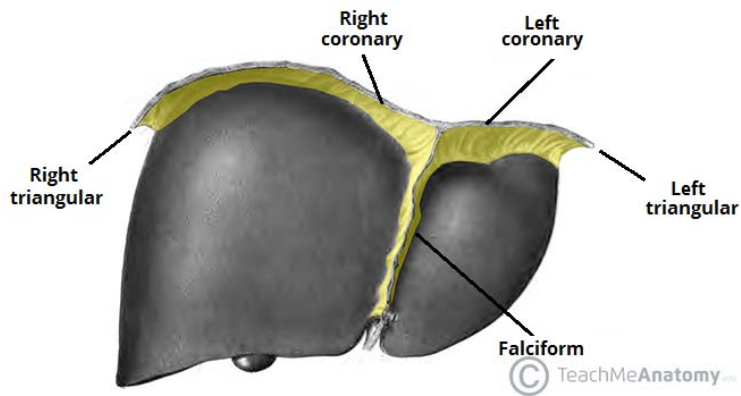
- Wedge shaped • largest organ in body • Weight 1500g
- 1500ml blood flow per minute (30% of cardiac output)
- Lies: Right-6-10 ribs/costal cartilages; Left-6-7 costal cartilages
- Surfaces: Anterior, superior, posterior, right - all smooth/convex  
Postero-inferior (visceral) concave & many features
- Supports: IVC & hepatic veins (+ ligamentum teres & peritoneum)
- Nerve supply: Right vagus via coeliac ganglia, left directly to porta hepatis.  
Sympathetics on vessels
- Reaches: T5 vertebra, nipples (5th intercostal space), xiphisternal joint



- Left and right subphrenic & subhepatic spaces
- Main supports are hepatic veins & IVC
- Lymphatics to coeliac, para-aortic, post. mediastinal, axillary & inguinal

**UNDER SURFACE OF LIVER**



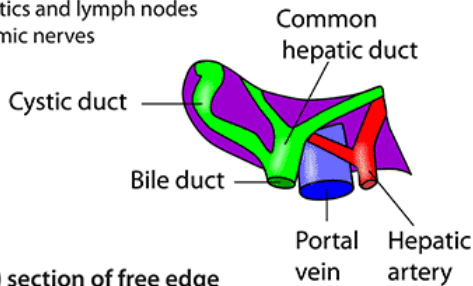


### LIVER - PORTA HEPATIS

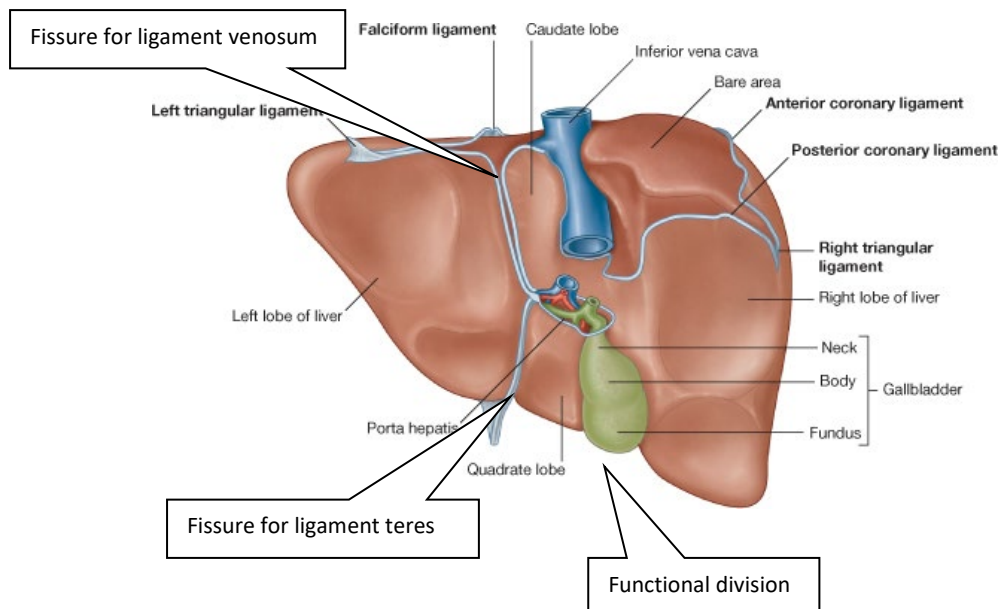
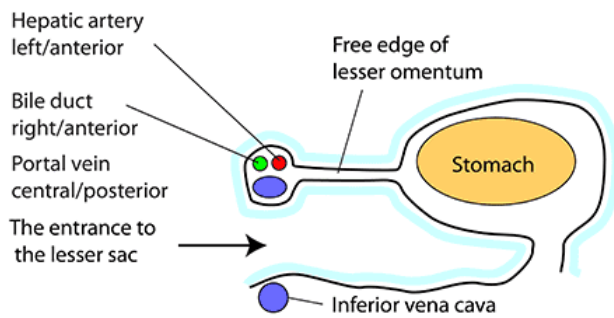
The **porta hepatis** is the area on the under surface of the liver at which the structures in the free edge of the lesser omentum enter/leave the liver. Peritoneum is reflected around it.

It contains the following structures:

- Portal vein
- Left/right branches of hepatic artery
- Left/right hepatic ducts
- Lymphatics and lymph nodes
- Autonomic nerves



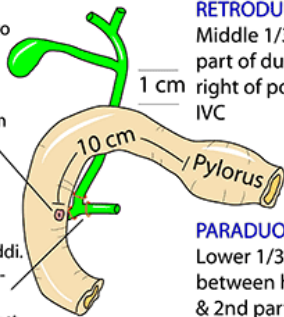
Cross (axial) section of free edge of lesser omentum looking up



**BILE DUCT**  
(8CM LONG  
8 MM WIDE)

Ampulla of Vater opens into 2nd part of duodenum on posteromedial wall, 10cm from pylorus

Sphincter of Oddi.  
3 parts around -  
1. Bile duct  
2. Pancreatic duct  
3. Ampulla



**SUPRADUODENAL**

Upper 1/3 in free edge of lesser omentum, with hepatic artery & portal vein



**RETRODUODENAL**

Middle 1/3 posterior to 1st part of duodenum, now to right of portal vein and on IVC



**PARADUODENAL**

Lower 1/3 in groove between head of pancreas & 2nd part of duodenum on right renal vein & IVC



**Blood:**

cystic, hepatic, gastroduodenal arteries

**Nerves:**

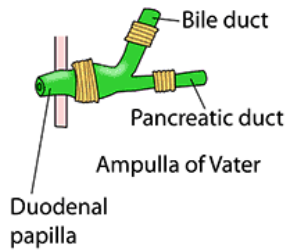
**Parasympathetic** - anterior vagus for contraction of gallbladder, relaxation of sphincter of Oddi (+ cholecystikinin from small bowel)

**Sympathetic** - coeliac ganglion, relaxes gallbladder

**Sensation:** General visceral afferent with sympathetics and somatic via phrenic

**SPHINCTER OF ODDI**

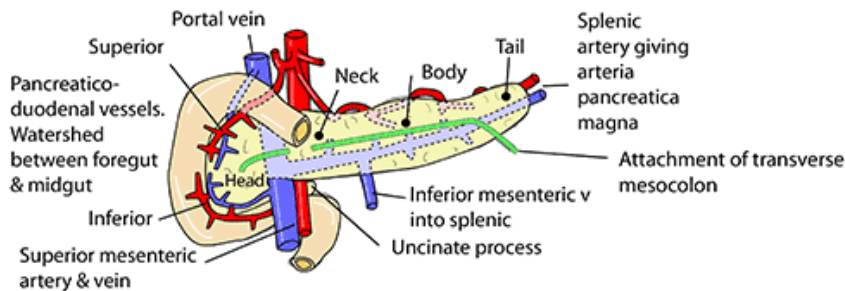
3 sphincters make up this Sphincter of Oddi. Biliary is always present - others may be missing



**PANCREAS:**

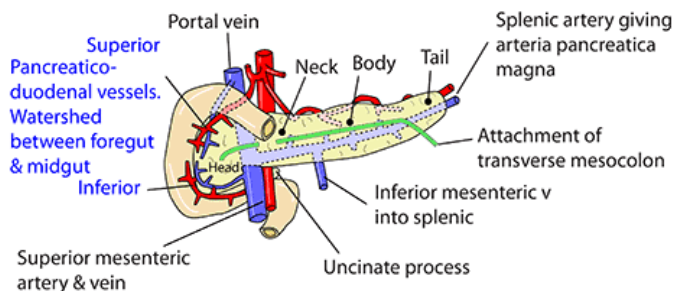
## PANCREAS - GENERAL

- Exocrine volume much greater than endocrine
- Lies retroperitoneal, largely in the transpyloric plane
- 15cm long, lobulated with fine capsule
- Alveoli of serous secretory cells lead to ductules then to principal ducts
- Islets of Langerhans lie between alveoli
- Main duct (Wirsung) leads to ampulla of Vater
- Accessory duct (Santorini) from uncinete process opens proximally, may be absent, often communicates with main duct
- Arteries: Gastroduodenal, inferior/superior pancreaticoduodenal, arteria pancreatica magna from splenic
- Veins: Pancreaticoduodenal. Superior to portal, inferior to superior mesenteric
- Lymphatics: in groove between head and duodenum & root of superior mesenteric artery and vein
- Nerves: Parasympathetic (posterior vagus) to stimulate exocrine secretion. Sympathetic for vasoconstriction and pain
- Secretion: Amylase. Secretin causes juice rich bicarbonate; cholecystokinin causes juices rich in enzymes - trypsinogen, chymotrypsinogen and pancreatic lipase. Alpha islet cells give glucagon, beta cells give insulin, delta give somatostatin. Pancreatic polypeptide is produced by the tail of the pancreas.



## PANCREAS - RELATIONS

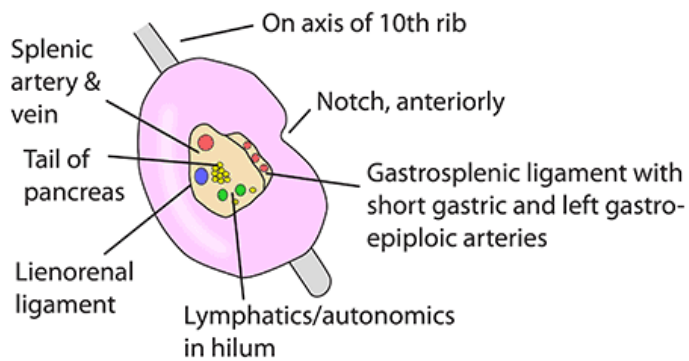
- Anterior:** lesser sac, pylorus, 1st part of duodenum, superior mesenteric artery & vein, transverse mesocolon, stomach
- Superior:** splenic artery
- Lateral on right:** 2nd part of duodenum, ampulla of Vater
- Lateral on left:** hilum of spleen
- Posterior:** left crus of diaphragm, psoas, right renal vein, inferior vena cava, bile duct, spleen, left renal vessels, left kidney, left suprarenal gland, coeliac plexus, inferior mesenteric vein, splenic vein, portal vein, superior mesenteric artery & vein, aorta



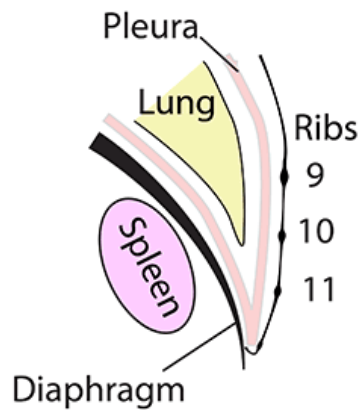
## SPLEEN

### SPLEEN - GENERAL

- Size of a fist (1 x 3 x 5 inches) 2.5cm x 8cm x 13cm
- 200g in weight. Lies on ribs 9 -11
- Part of the reticuloendothelial system
- Becomes palpable when it is twice normal size
- Thin capsule, has notch & moves on respiration (cf. kidney)
- Functions: Erythropoiesis, effete erythrocyte removal, immune defence (beta cells) and blood storage
- Blood supply: Splenic artery from coeliac trunk
- Venous drainage: Splenic vein to portal system
- Lymph: Coeliac (para-aortic)
- Nerve: Sympathetic from coeliac plexus



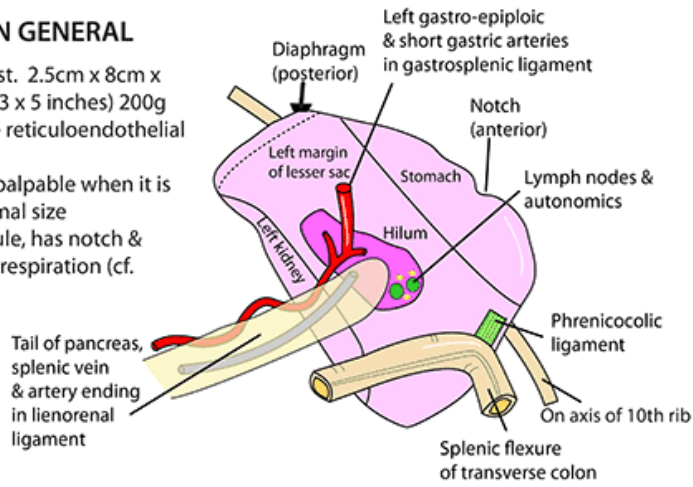
Note: lower pole is normally no further anteromedial than mid axillary line



## SPLEEN - RELATIONS & DEVELOPMENT

### SPLEEN GENERAL

- Size of a fist. 2.5cm x 8cm x 13cm (1 x 3 x 5 inches) 200g
- Part of the reticuloendothelial system
- Becomes palpable when it is twice normal size
- Thin capsule, has notch & moves on respiration (cf. kidney)



**Blood supply:** Splenic artery from coeliac trunk

**Venous drainage:** Splenic vein to portal system

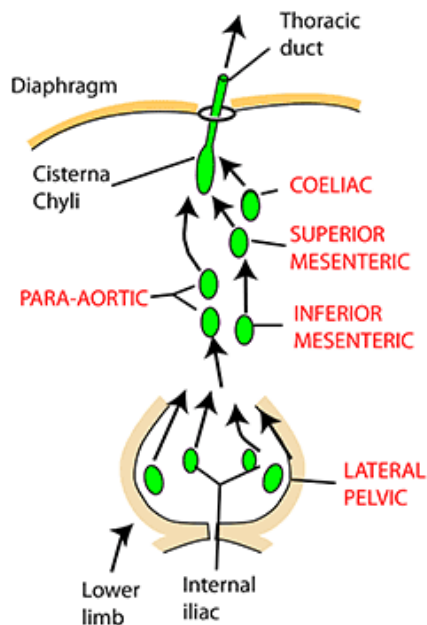
**Lymph:** Coeliac (para-aortic)

**Nerve:** Sympathetic from coeliac plexus

### LYMPH



## ABDOMINOPELVIC LYMPHATICS



### COELIAC

- Lower 1/3 oesophagus
- Stomach, greater omentum
- 1st/upper 2nd parts of duodenum
- Spleen
- Pancreas
- Liver
- Gall bladder

### SUPERIOR MESENTERIC

- Lower 2nd, 3rd, 4th parts of duodenum
- Jejunum
- Ileum
- Caecum & appendix
- Ascending/transverse colon

### INFERIOR MESENTERIC

- Distal transverse colon
- Descending/sigmoid colon
- Upper rectum & mucosa to dentate line

### LATERAL PELVIC

- Lower rectum & dentate line
- Bladder
- Urethra
- Lower ureter
- Uterus, cervix, upper vagina, clitoris, labia minora (female)
- Vas, seminal vesicles, prostate, bulk of penis (male)

### PARA-AORTIC

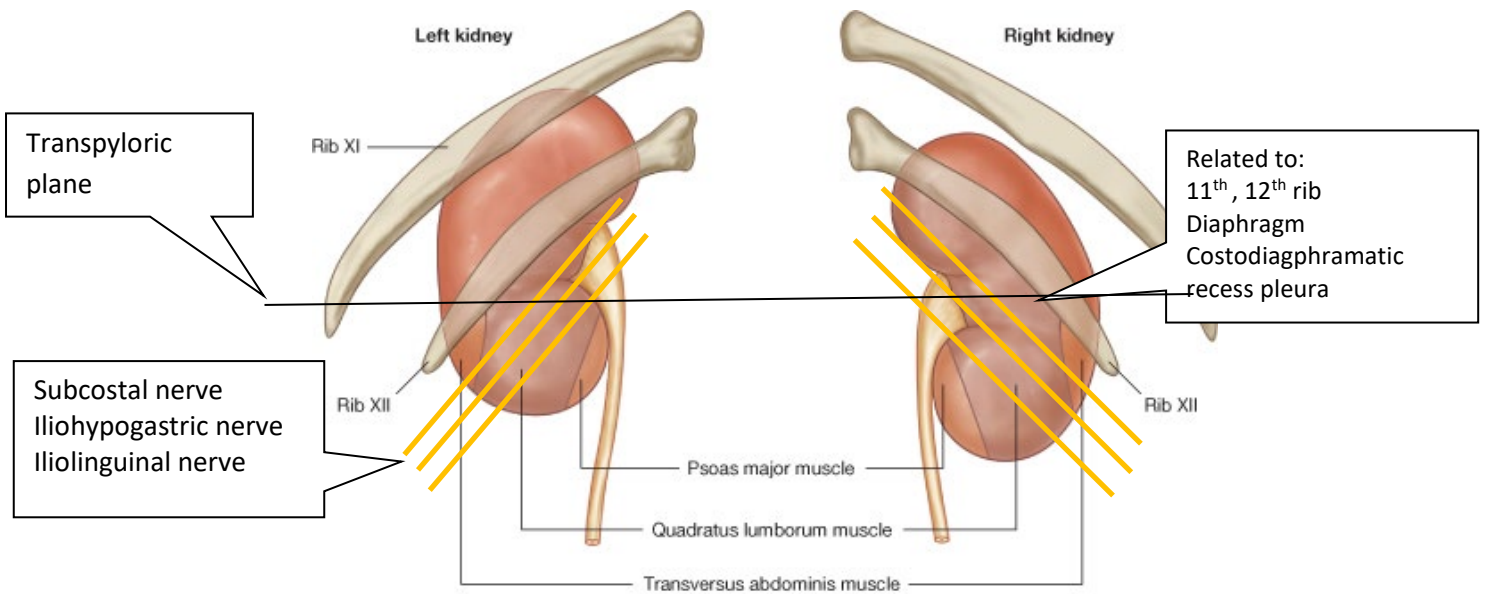
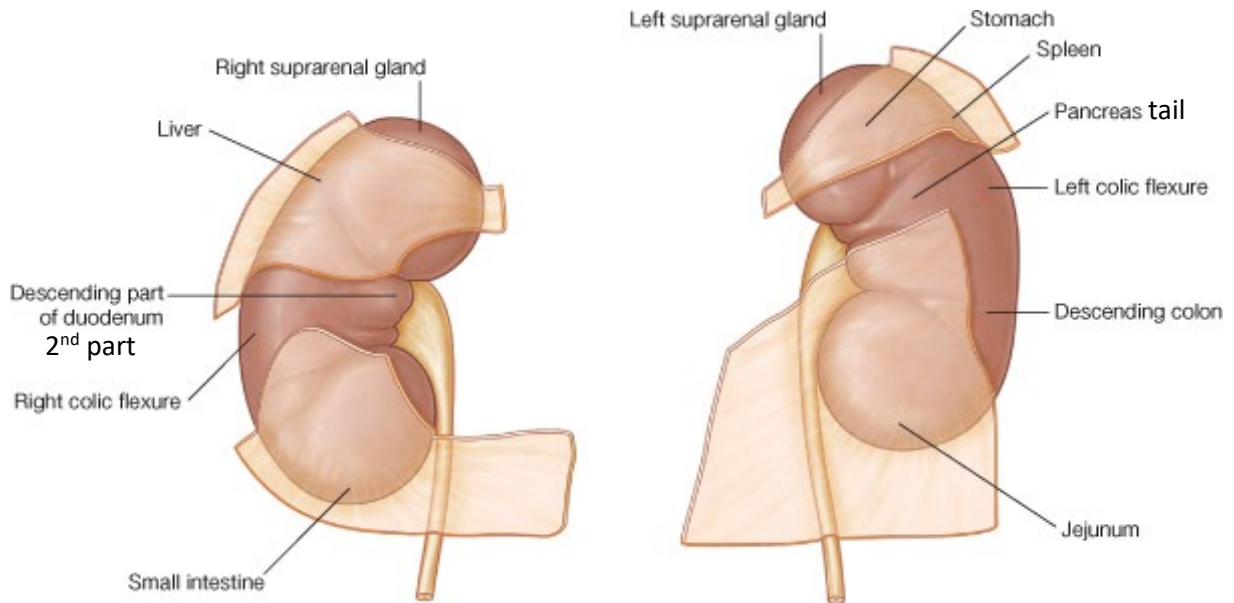
- Inferior surface diaphragm
- Bare area of liver
- Suprarenal glands
- Kidneys & ureters
- Gonads (+ tube in female)
- Superior/lateral uterus
- Posterior abdominal wall

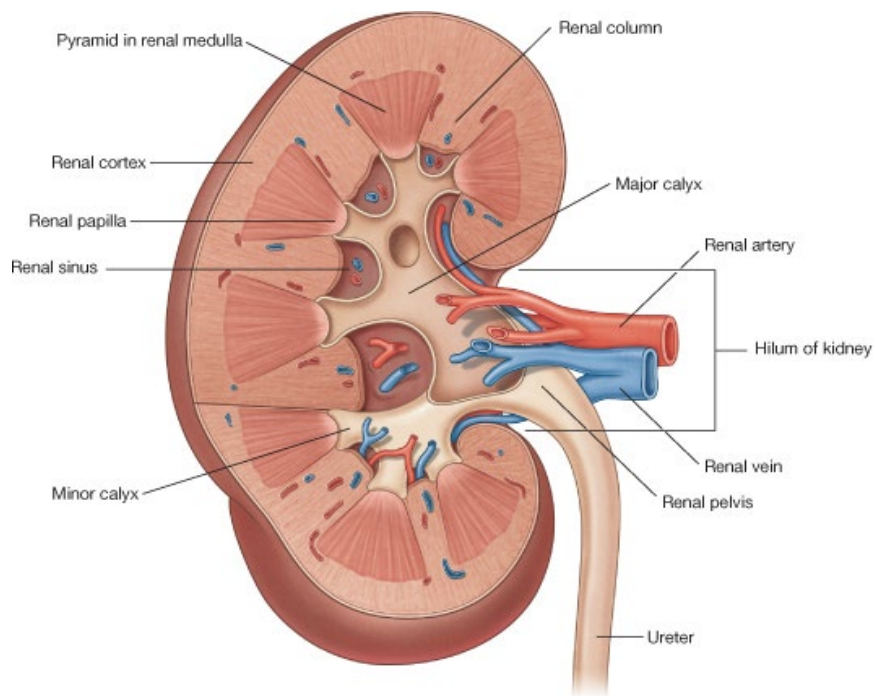
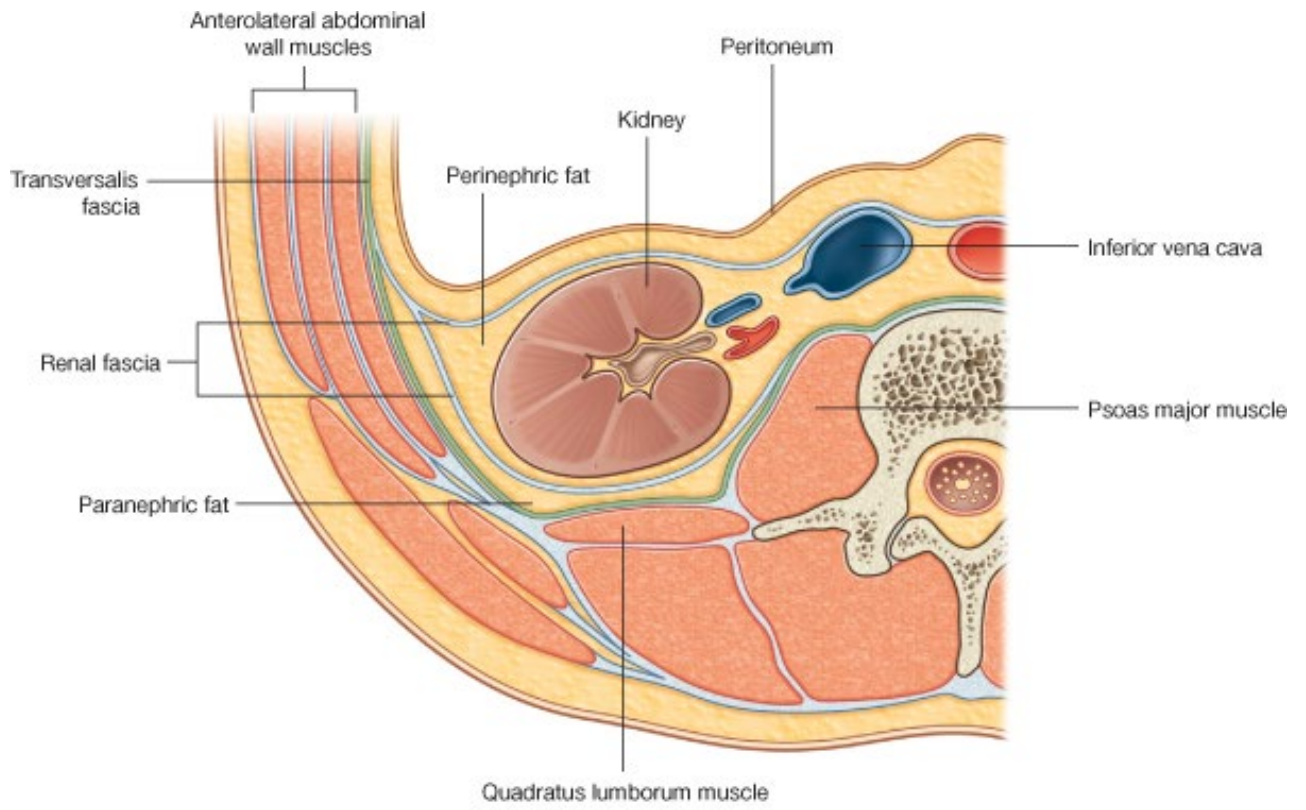
### LYMPHATIC DRAINAGE OF THE ABDOMEN:

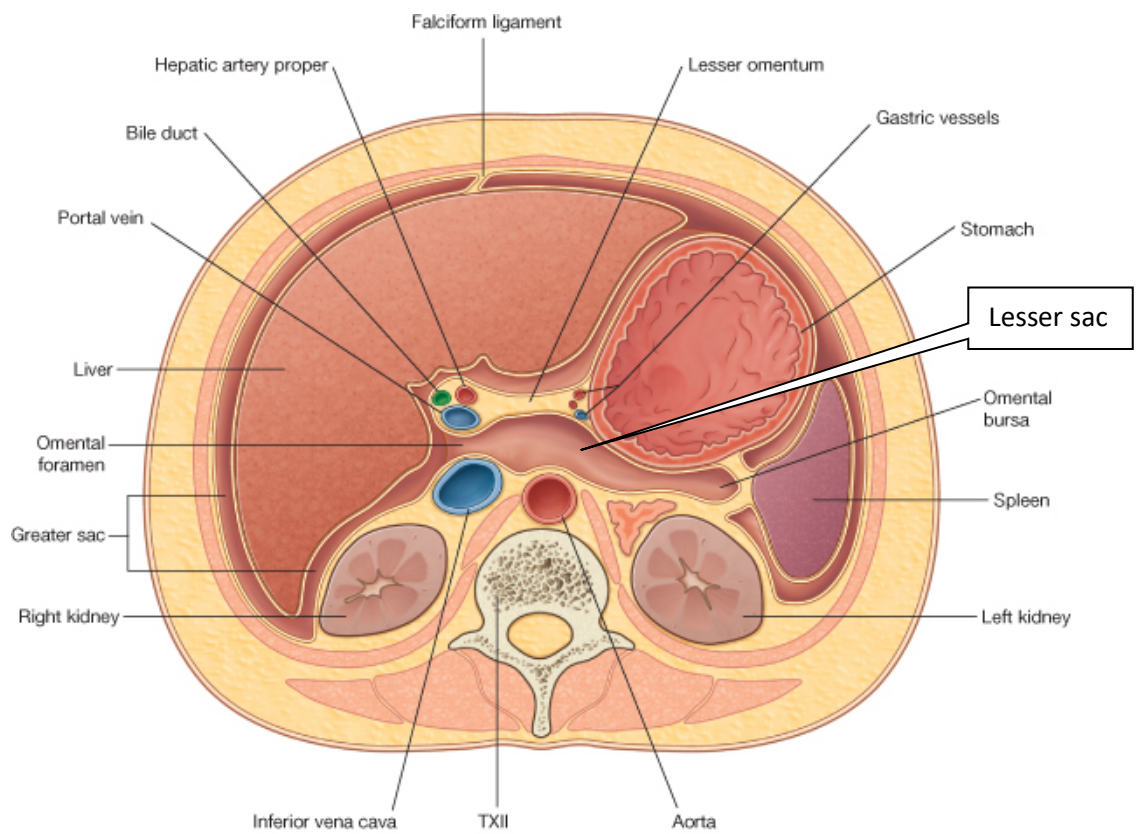
- Preaortic lymph nodes: anterior to abdominal aorta
  - Celiac nodes
  - Superior mesenteric nodes
  - Inferior mesenteric nodes
  - (drain the organs associated with each of the above)
- Para-aortic / lumbar lymph nodes: either side of the abdominal aorta
- Preaortic nodes form the intestinal trunk
- Para-aortic nodes form right and left lumbar trunks
- Join to form the sacular dilation, the cysterna chyli
- Cysterna chyli then connects up to the thoracic duct.

## KIDNEYS

- Move during breathing because they are related to the diaphragm

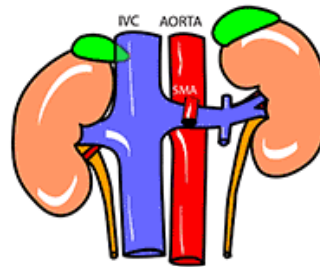
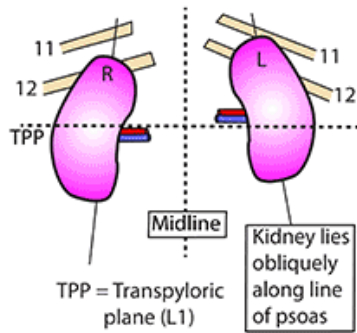






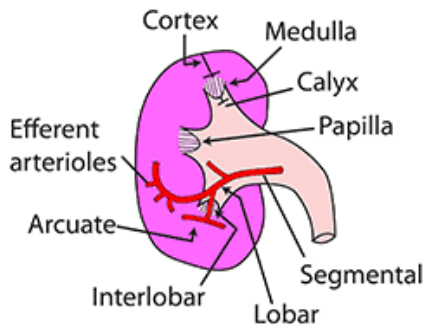
## KIDNEYS - GENERAL

- 120g each, 11x6x4cm, 1200ml blood/minute
- Retroperitoneal, move 2.5cm on respiration
- Pelvis faces medially/anterior
- 1 million nephrons/kidney
- Lymphatics to para-aortics
- Sympathetic from T12-L1 for vasoconstriction & pain
- Parasympathetics from vagus. Function unknown
- Polar & capsular vessels give minimal collateral supply



Order of structures at hilum from anterior to posterior V-A-U (vein, artery, ureter)

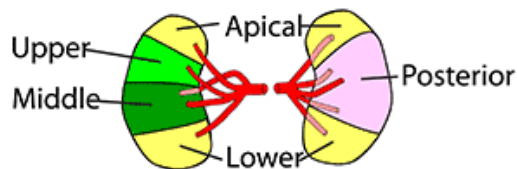
Left renal vein is longer making left nephrectomy easier



Segmental blood supply

ANTERIOR VIEW

POSTERIOR VIEW



Liver = 30% CO

Kidneys = 25% CO

Order at hilum:

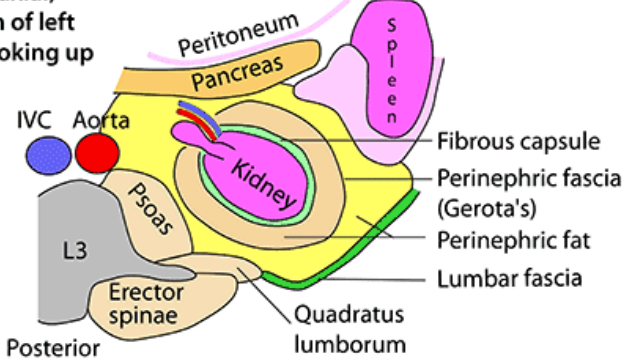
Liver: BAV (bile-artery-vein)

Kidney: VAU (vein-artery-ureter)

*I.e. kidney is opposite to liver*

## KIDNEY - RELATIONS

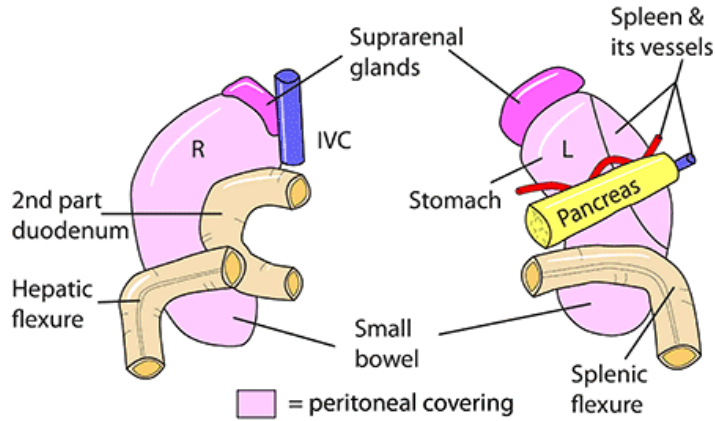
Cross (axial)  
section of left  
side looking up



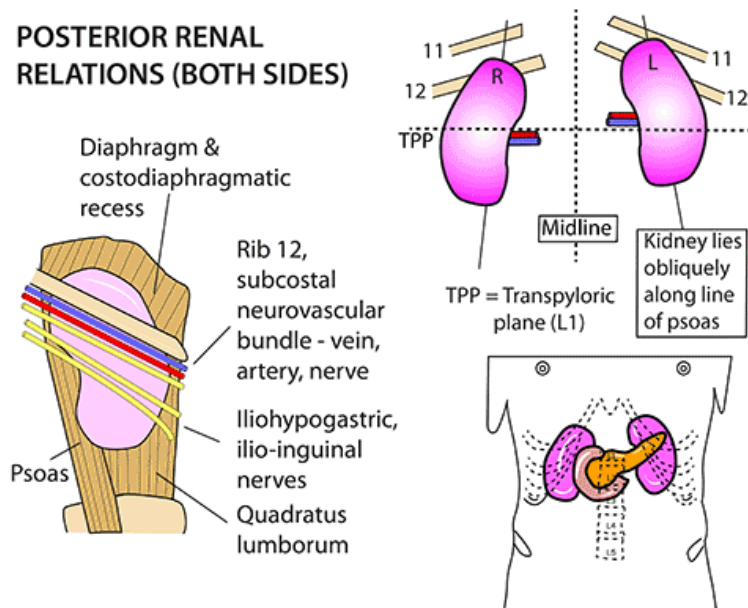
Note: The perinephric fascia is attached around the renal pelvis but is open inferiorly so that pus or extravasated urine can track down alongside the ureter.

**Kidneys move 3-4cm on respiration**

## ANTERIOR RELATIONS OF KIDNEYS



## POSTERIOR RENAL RELATIONS (BOTH SIDES)



### STRUCTURE OF THE KIDNEY:

- Outer fibrous capsule
- Hilum of kidney: (anterior → posterior)
  - Renal vein
  - Renal artery
  - Ureter
- Perirenal fat continues into hilum and sinus
- At the hilum the ureter opens out to form renal pelvis
- Renal pelvis + vessels = renal sinus
- Pelvis bifurcates/trifurcates → major calyces
- Major calyces bifurcate/trifurcate → minor calyces
- Minor calyces collect urine.
  
- Renal cortex surrounds medulla.
- Extensions of renal cortex – renal columns – extend into medulla
  
- Renal medulla
  - Arranged into renal pyramids
  - Papillae (apices of pyramids) point towards the minor calyces

### Ureters:

- Muscular tubes transporting urine from kidneys to bladder
- Join the renal pelvis at the ureteropelvic junction
- Descend **retroperitoneally** on psoas muscle
- Cross over common iliac artery (over bifurcation)
- Enter bladder.
  
- 3 constrictions of ureter:
  1. **At ureteropelvic junction (just inferior to kidneys)**
  2. **Where the ureters cross common iliac artery**
  3. **Where ureters enter wall of bladder.**
- Common sites for kidney stones to get stuck → intense referred pain to loin and groin.

## URETER

25cm long. From kidney to bladder

**Posterior relations:** Psoas, genitofemoral nerve, sacroiliac joint, common iliac artery bifurcation

**Anterior relations: Right-** Duodenum, right gonadal artery, right colic artery, ileal mesentery, superior mesenteric artery. **Left-** Left gonadal artery, left colic artery, sigmoid mesentery

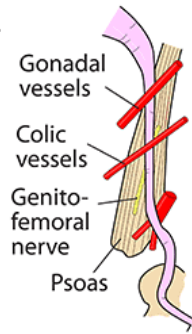
**Passes under:** Vas, uterine artery

**Related to:** Lateral fornix of vagina in females

**Blood supply:** Renal, gonadal, vesical. Smaller branches from aorta, common iliac & vaginal arteries

**Nerves:** General visceral afferents for pain & sympathetics probably for vasoconstriction only

**Points of potential hold up:** Pelviureteric junction, pelvic brim, ureterovesical junction



It is recognisable as it:

- Is the most superficial structure in the pelvis
- Shows peristalsis
- Sticks to the posterior surface of the peritoneum
- Passes around the pelvic brim to 1cm short of the ischial spine then swings medially.
- Enters the bladder at the level of the pubic tubercle on a plain abdominal X-ray
- Right ureter may be irritated by an inflamed appendix
- Pain is referred to loin, groin & tip of penis

## SUPRARENAL GLANDS:

- **Medulla secretes adrenaline**
- Right: pyramid shaped
- Left: semilunar shaped and larger
- Surrounded by perirenal fat and enclosed in renal fascia
- Thin septum separates each gland from its associated kidney

*Posterior associations:*

- Diaphragm

*Anterior associations:*

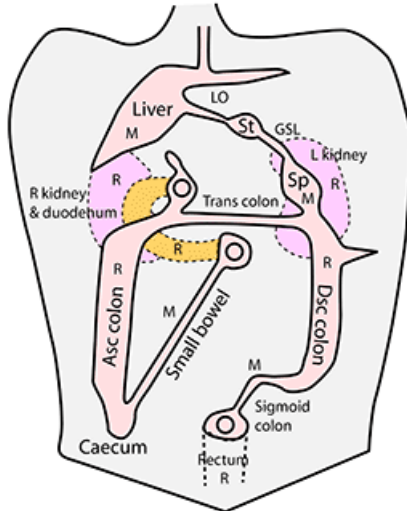
- Right:
  - Liver
  - IVC
- Left:
  - Stomach
  - Pancreas
  - Spleen
- Innervation of the suprarenal glands is via:
  - Celiac plexus
  - Greater thoracic splanchnic
- **Innervation is by preganglionic sympathetic only**
- **Abdominal organs in direct relation with diaphragm:**
  - Right:
    - Liver, suprarenal gland, kidney
  - Left:



- Stomach, suprarenal gland, kidney, spleen

## PERITONEUM

### MESENTERIES 1



All the intestines have been removed as far posterior as possible leaving the cut edges of the peritoneum. If the area of denuded peritoneum is narrow then the piece of bowel was on a mesentery. If it is wide then it was retroperitoneal, the exception being the stomach.

M = Mesentery  
 R = Retroperitoneal  
 St = Stomach  
 Sp = Spleen  
 Lo = Lesser omentum

Note: Small bowel mesentery runs from the left L2 transverse process to the right sacro-iliac joint (S2). It is 6 inches (15cm) long and crosses left psoas, aorta, IVC, right psoas, right ureter, right common iliac bifurcation & into right iliac fossa

## PERITONEUM

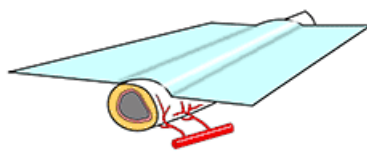
### PARIETAL

Serous membrane  
 Lines abdominal cavity  
 Nerve: somatic, intercostals

### VISCERAL

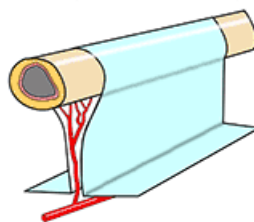
Serous membrane  
 Forms all mesenteries  
 Covers all retroperitoneal organs  
 Nerve: Probably has general visceral afferents, carried by sympathetics detecting stretch and inflammation

### RETROPERITONEAL



- Most of duodenum
- Ascending colon
- Descending colon
- Rectum
- Pancreas
- Kidneys

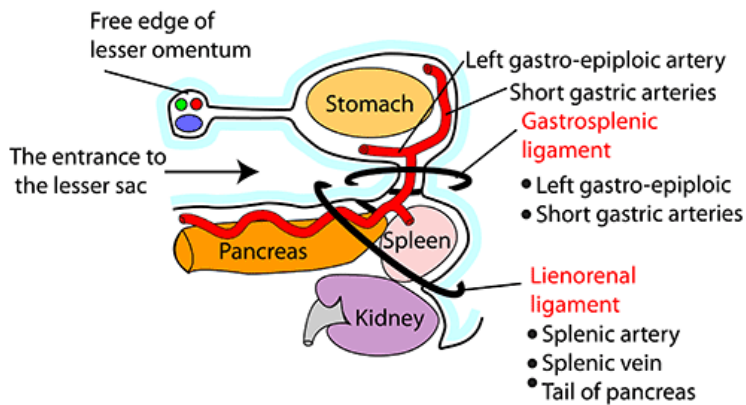
### ON A MESENTERY



- Stomach
- 1st half of 1st part of duodenum
- 2nd half of 4th part of duodenum
- All small bowel
- Caecum (size dependent)
- Appendix
- Transverse colon
- Sigmoid colon

## LIENORENAL & GASTROSPLENIC LIGAMENTS

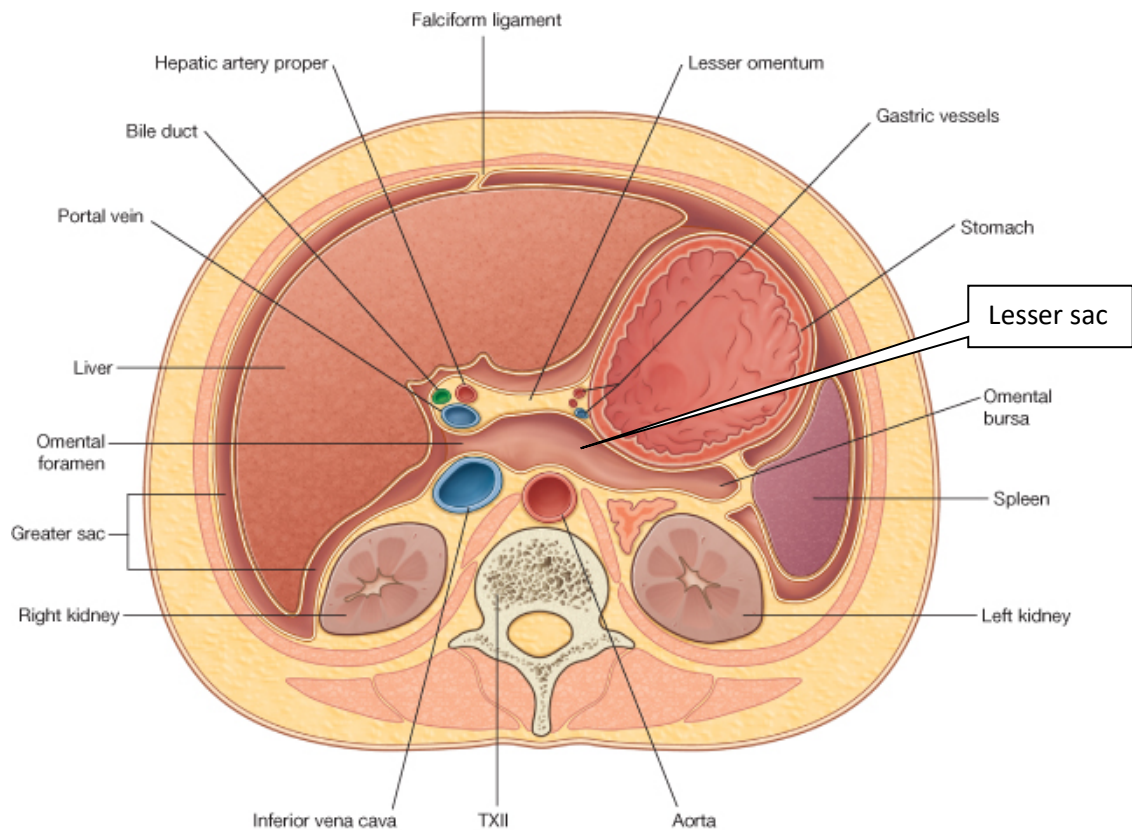
### AXIAL SECTION ACROSS FAR LEFT SIDE OF LESSER SAC



The **gastrosplenic ligament** contains the short gastric & left gastro-epiploic vessels

The **lienorenal ligament** contains the tail of pancreas & splenic vessels)

The two ligaments are the remnants of the the dorsal mesentery of the stomach. The ventral mesentery is the lesser omentum and the falciform ligament



## ORGANS AND THEIR RELATED MESENTERIES:

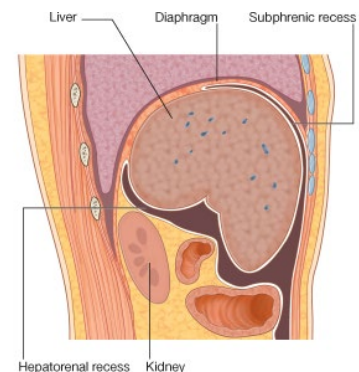
- Parts of gut within ventral mesentery:
  - Liver
  - Stomach
- Parts of gut within dorsal mesentery:
  - Stomach
  - Spleen
  - Transverse colon
  - Sigmoid colon
- Parts of gut with no mesentery (retroperitoneal):
  - Pancreas
  - Duodenum
  - Ascending colon
  - Descending colon
  
- Greater omentum: 4 layers of peritoneum
- Lesser omentum: 2 layers of peritoneum
  
- Greater sac: the main part of the peritoneal cavity.
- It is divided into two sections by the transverse mesocolon;
  - **Supracolic compartment** – between the diaphragm and transverse mesocolon
  - **Infracolic compartment**
- The infracolic compartment is further divided into right and left infracolic spaces by "the mesentery".

### *Contents of supracolic compartments:*

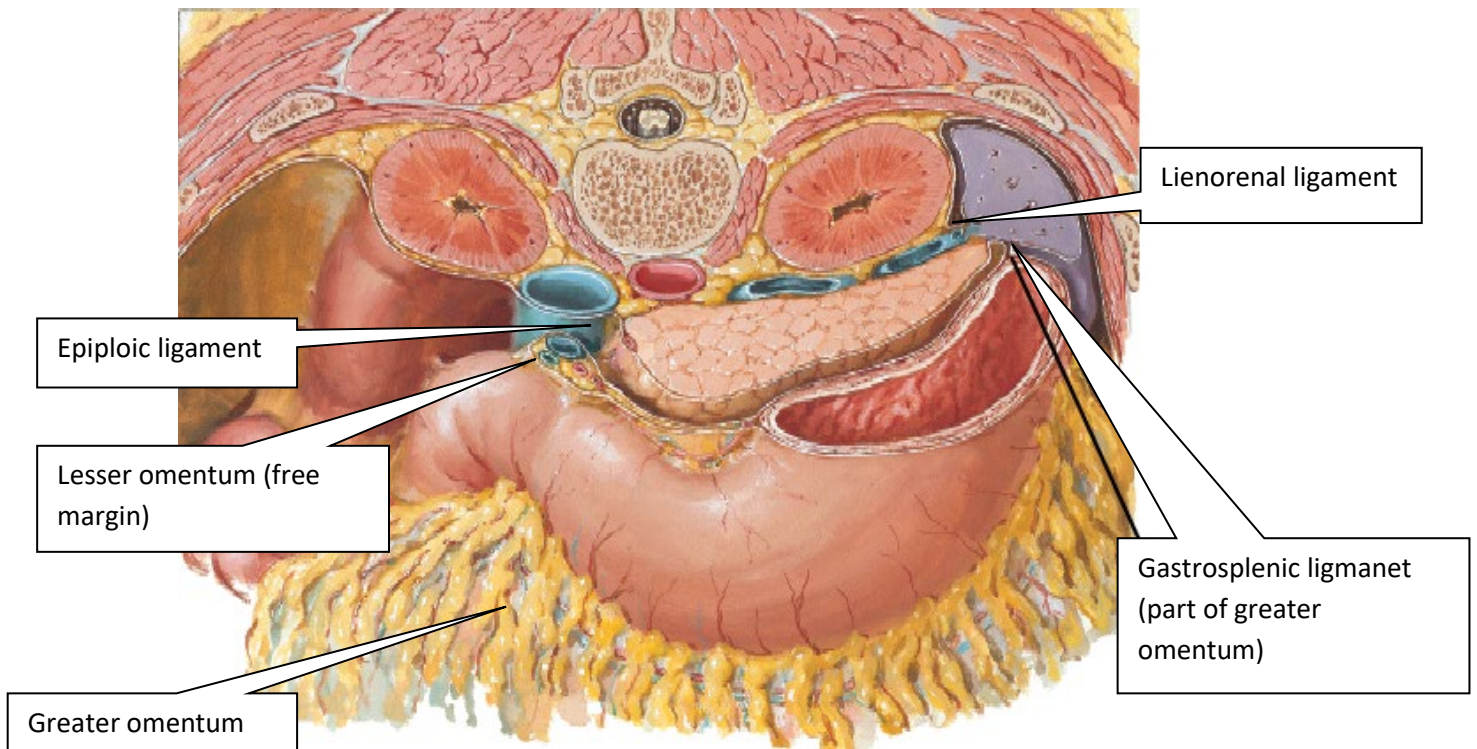
- the abdominal part of the oesophagus,
- stomach,
- duodenum,
- liver,
- spleen,
- pancreas,
- extrahepatic biliary apparatus

### *Contents of the infracolic compartments*

- Major part of the lower digestive track,
  - jejunum
  - ileum
  - cecum (+ appendix)
  - colon.
  
- **Subphrenic space:**
  - Recesses in the peritoneal cavity between the anterior part of the liver and the diaphragm
  - Separated into right and left by the falciform ligament.
  
- **Hepatorenal recess:**



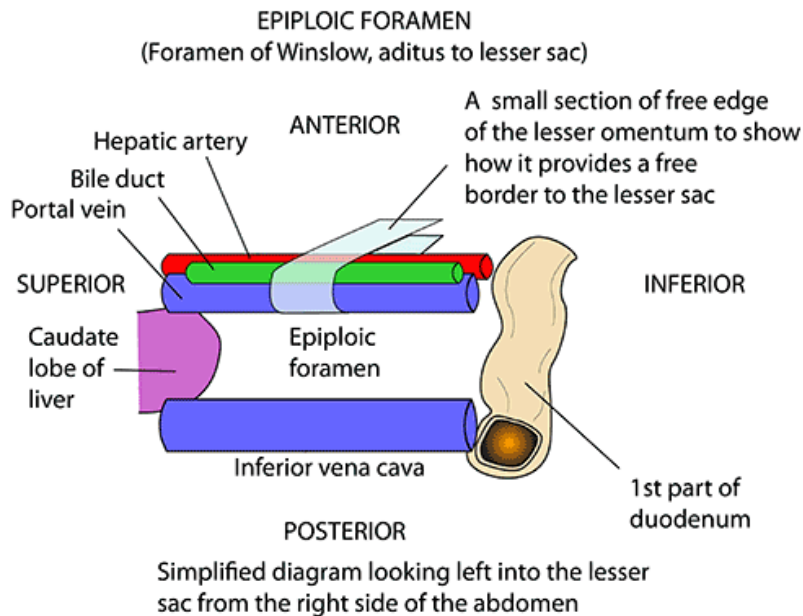
- Part of peritoneal cavity on RHS between the liver and right kidney and right suprarenal gland.
  - Subphrenic and hepatorenal recesses are continuous anteriorly
  - Hepatorenal recess and right paracolic gutter continuous
  - Hepatorenal recess is a common site of fluid accumulation in supine patients.
- **Rectouterine pouch (Pouch of Douglas):**
    - Part of peritoneal cavity between the rectum and back wall of the uterus
    - Lowest part of peritoneal cavity in women
    - Common site of accumulation of fluid/pus
    - Dialysis catheter is put into rectouterine pouch for kidney failure.



- **Lesser sac (aka omental bursa)**
  - Formed by lesser and greater omentum
  - Anterior wall:
    - Lesser omentum (containing portal vein, bile duct, hepatic artery)
    - Stomach
    - Gastrosplenic ligament
- **Epiploic foramen:**
  - Anterior: free border of lesser omentum, containing
    - Hepatic artery
    - Bile duct
    - Portal vein
    - (learn the arrangement)



- Posterior: peritoneum covering IVC
- Superior: peritoneum over caudate lobe of liver
- Inferior: peritoneum covering duodenum



#### SOME SPL QUESTIONS:

- ✚ **Failure of closure of the processus vaginalis can lead to:**
  - Peritoneal fluid can travel down a patent processus vaginalis / build up after injury leading to the formation of a **hydrocele**.
  - Potential for an **indirect inguinal hernia** to develop, although not all people with a patent processus vaginalis will develop one. The more patent the processus vaginalis, the more likely the patient is to develop a hernia.
  - Persistent patent processus vaginalis more common on the right than the left
- ✚ The **superficial inguinal lymph nodes** form a chain immediately below the inguinal ligament.
- ✚ They drain:
  - Penis
  - Scrotum
  - Perineum
  - Buttock
  - Abdominal wall below level of umbilicus
  - Vulva
  - Anus
- ✚ NOTE the testes drain to the **para-aortic lymph nodes**

#### Peritoneum:

- ✚ Layer of cells – **mesothelium** – and supportive CT
- ✚ Parietal – lines abdominal wall

- ✚ Visceral – covers suspended (intraperitoneal) organs
- ✚ Peritoneal cavity is filled with viscera.

✚ Abdominal organs can be:

- Retroperitoneal – between parietal peritoneum and abdominal wall
- Intraperitoneal – suspended from abdominal wall by mesenteries.

Nerve supply to peritoneum:

- Parietal peritoneum:
  - T7-T12 + L1 (**somatosensor**)
  - Obturator nerve in pelvis
  - Sensations of:
    - Pain
    - Temperature
    - Touch
    - Pressure
- Visceral peritoneum:
  - **Visceral afferents** travelling in the mesenteries from the visceral organs
  - Sensitive to stretch only.

Peritoneal Folds

- ✚ A peritoneal fold is a reflection of peritoneum with more or less sharp borders.
- ✚ Often it is formed by peritoneum that covers blood vessels, ducts, and obliterated foetal vessels.
- ✚ Several folds are visible on the parietal peritoneum on the interior of the anterior abdominal wall.
- ✚ The **median umbilical fold** contains
  - The **urachus** (embryological remnant) which extends from the urinary bladder to the umbilicus.
- ✚ The **medial umbilical folds** contains
  - **Obliterated umbilical arteries**, extending from the internal iliac arteries to the umbilicus.
- ✚ The **lateral umbilical folds** contains
  - **Inferior epigastric arteries**, extending from the deep inguinal rings on each side to the arcuate lines.

Small intestine	Large intestine
Longitudinal muscle continuous	Longitudinal muscle reduced to 3 taeniae coli
Intraperitoneal except duodenum	Retroperitoneal, except transverse colon and sigmoid colon.
No appendices epiploicae	Appendices epiploicae
Segmentation and peristalsis	Mainly segmentation & bulk movements

Nutrient absorption & fluid absorption

Fluid and electrolyte absorption

- **Ligamentum venosum:**
  - Remnant of ductus venosus
  - Shunted oxygenated blood from left umbilical vein past liver into the IVC
- **Ligamentum teres:**
  - Obliterated remnant of left umbilical vein

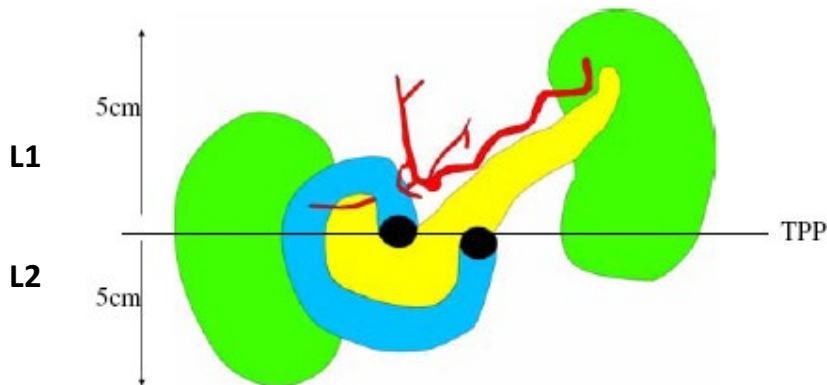
#### LYMPHATIC DRAINAGE OF STOMACH:

- Lymph drains back along route of the arteries supplying stomach
- Eventually all **drains into celiac group of nodes** → thoracic duct
  - Celiac group
  - Suprapancreatic group
  - Subpyloric nodes
  - Splenic nodes

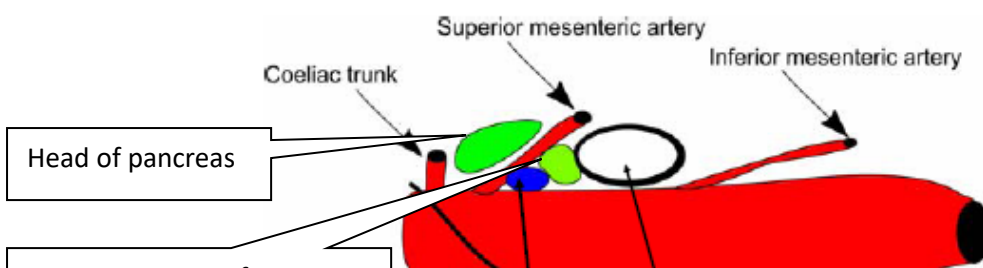
#### INFERIOR VENA CAVA:

- If the IVC becomes blocked, blood from the lower part of the body can form a collateral circulation through the **ascending lumbar veins** to join the azygos and hemiazygos veins, and then the SVC.
- Also through left gastric vein → oesophagus → azygos → SVC

#### LOCATION OF VISCERAL ABDOMINAL ORGANS IN RELATION TO THE TRANSPYLORIC PLANE



- Several things are found on the transpyloric plane:
  - Pyloric sphincter
  - Pancreas head
  - Beginning and end of duodenum
  - Hilum of the kidneys
  - Fundus of the gallbladder
  - Splenic vein
  - Beginning of SM artery
  - End of spinal cord



- **TAKE NOTE: LAPT KEEPS ASKING:**
  - Main head of pancreas is in front of the superior mesenteric artery
  - The uncinate process of pancreas is behind the superior mesenteric artery.
  
- **PSOAS MAJOR AND ILIACUS ARE IMPORTANT FLEXORS OF THE THIGH**
- Aorta passes through diaphragm beneath the **median arcuate ligament**
- Psoas major passes underneath the **medial arcuate ligament**
- Quadratus lumborum passes underneath the **lateral arcuate ligament**
  
- **Errector spinae** muscles are innervated by dorsal rami.