

# **THE ABDOMEN**

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# SURFACE ANATOMY

## SURFACE MARKINGS

<b>Xiphoid process:</b>	<b>T9-T10</b>
<b>Costal margin:</b>	From the <b>7<sup>th</sup> costal cartilage</b> to the lowest <b>tip of the 10<sup>th</sup> rib [L3]</b> or the tapering end of the 11 <sup>th</sup> rib.
<b>9<sup>th</sup> costal cartilage:</b>	A distinct <b>palpable</b> step in the costal margin [mammary line]
<b>Subcostal plane:</b>	<b>L3</b>
<b>Transpyloric plane [Anderson]:</b>	<b>L1.</b> Halfway between the sternal notch and the pubis. It is the level where the pylorus, the neck of the pancreas, the duodenal flexure [descending] and the hilum of the kidneys lie.
<b>Umbilicus:</b>	<b>L3-4</b>
<b>Iliac crest:</b>	Level of umbilicus
<b>Anterior superior iliac spine: L5.</b>	The <b>inguinal ligament [Poupart's]</b> arises from it and passes downwards and medially to the <b>pubic tubercle</b>
<b>External inguinal ring:</b>	Is felt by invaginating the scrotal skin
<b>Vas deferens:</b>	Is felt in the scrotal neck, as a firm tube within the cord

## LIVER

- **Lower border:** line from the lowest costal margin to the left nipple
- **Upper:** transverse line below the nipples

## SPLEEN

- Underlies the 9<sup>th</sup>-11<sup>th</sup> ribs on the left

## GALLBLADDER

- Its fundus lies where the lateral edge of the rectus sheath crosses the costal margin [tip of the 9<sup>th</sup> cartilage]

## PANCREAS

- Lies in the pyloric plane of Anderson [L1], its head passing inferolaterally to the right while its tail passes superolaterally to the left.

## KIDNEYS

- Hilum on the transpyloric plane, 4 fingerbreadths from the midline. The upper pole lies deep and posteriorly to the 12<sup>th</sup> rib

## AORTA

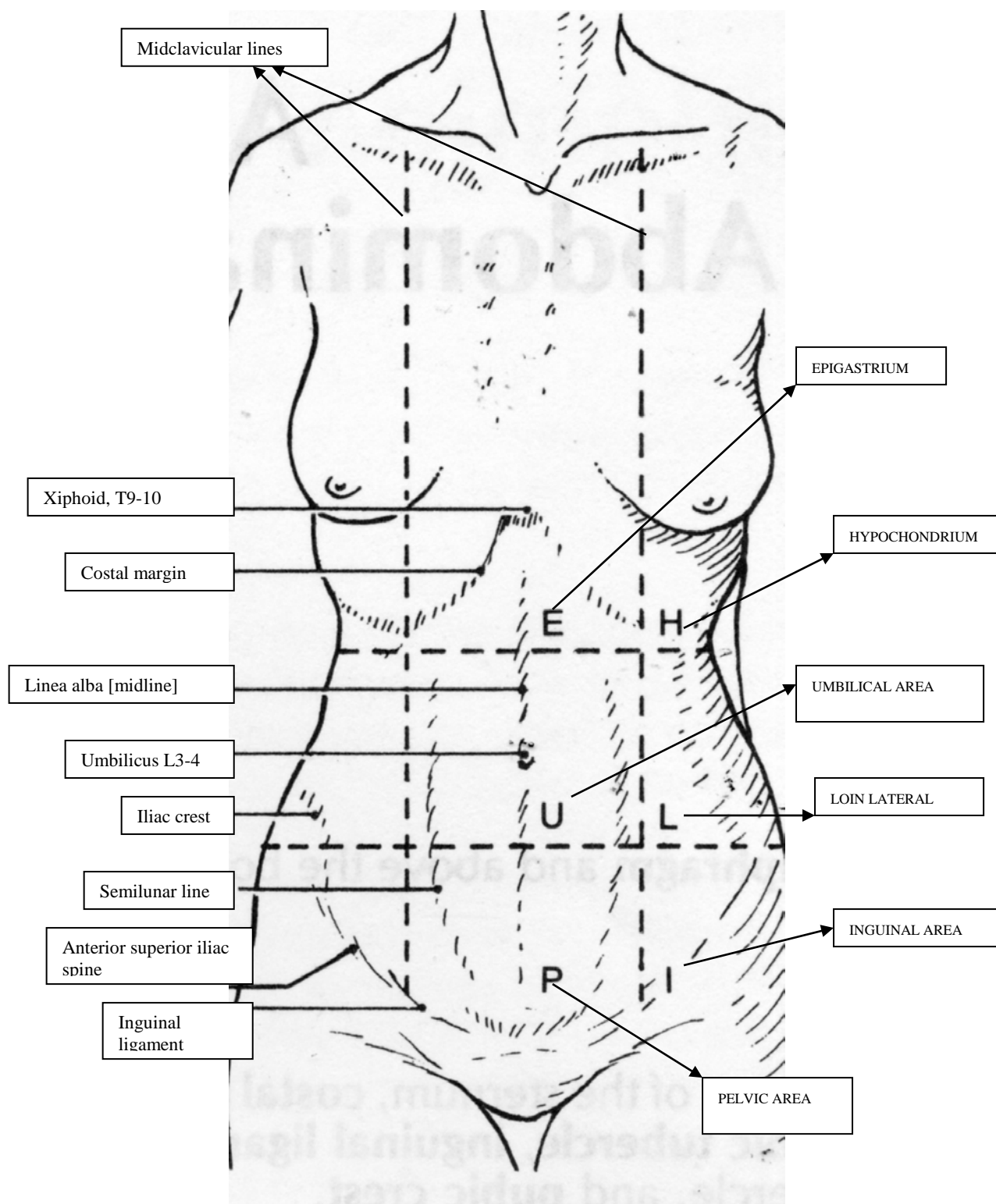
- Midline. Its bifurcation is at the level of iliac crests [L3-4]

## NERVE SUPPLY

T7-L1 segmental, through the **anterior cutaneous branches** of the **intercostal nerves** which pierce the rectus sheath

T10 umbilicus

L1 groin [**ilioinguinal nerve**] and scrotum [**iliohypogastric nerve**]



## ABDOMINAL FASCIÆ

There is no deep investing fascia in the abdomen, only the **superficial fascia**.

1. **Fatty [superficial] layer [Camper's fascia]** continuous with the fatty layer of all the body and Cruveilhier's fascia in the perineum
2. **Fibrous, deep layer [Scarpa's]**, continuous with the deep fascia of the thigh [fascia latta], scrotum and perineum [Colle's fascia]

## MUSCLES

The lateral muscles have a communicating nerve network while the innervation of the rectus muscle is segmental with little cross communication. This is the reason why the rectus atrophies after paramedian incisions.

### RECTUS

- **Origin:** 7.5cm line from 6<sup>th</sup> to 7<sup>th</sup> costal cartilages
- **Insertion:** 3 cm into the pubic crest
- **Transverse tendinous intersections:** At these points the **superior epigastric artery** branches [subclavian→ costocervical trunk→ internal mammary→ superior epigastric] cross the muscle. There is one at the **xiphoid** level, one at the **umbilicus**, **one halfway** between them and the 4<sup>th</sup> is **infraumbilical**
- **RECTUS SHEATH**
  - a. **Anterior layer:**
    - a. above the costal margin line → **external oblique aponeurosis**
    - b. costal margin till halfway from umbilicus to pubis → **external oblique &**
    - c. **anterior layer of internal oblique aponeurosis**
    - d. lower part → all **3 oblique muscles aponeuroses**
  - b. **Posterior layer:**
    - a. **costal cartilages**
    - b. **posterior layer of the bipetal internal oblique aponeurosis & transversus abdominis aponeurosis**
    - c. **transversalis fascia and peritoneum [arcuate line of Douglas]**
- **Semilunar line:** the lateral margin of the lower part of the rectus
- **Linea alba:** fusion of the aponeuroses from both sides. It is a whitish tissue, more prominent supraumbilically.
- Behind the rectus, at the Douglas line, the **inferior epigastric vessels** [branches of the external iliac] enter the sheath and travel upwards to join the superior epigastric vessels [continuation of the internal mammary]

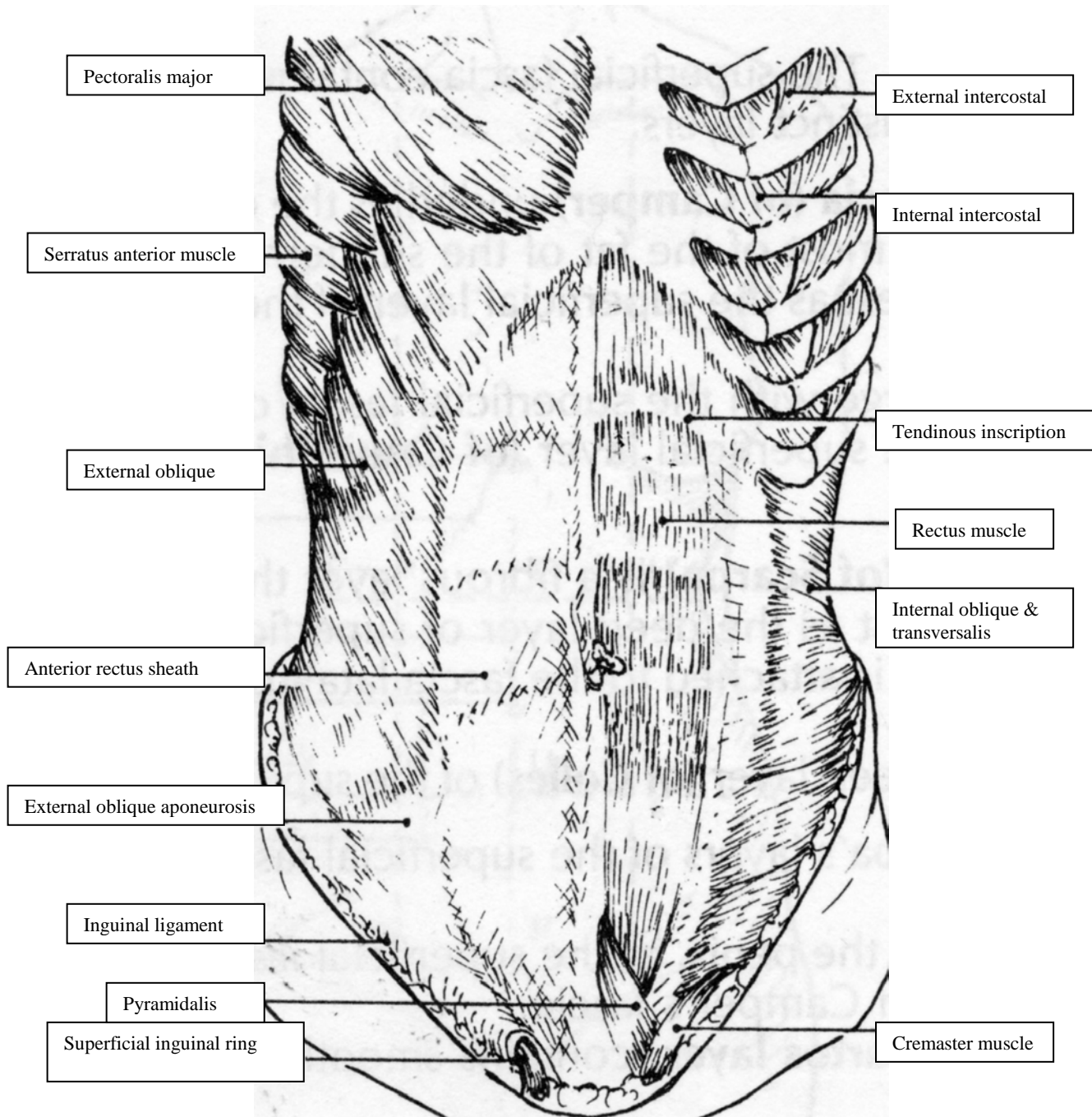
### EXTERNAL OBLIQUE

- **Origin:** outer surface of lower 8 ribs
- **Course:** passes downwards and forwards
- **Insertion:** xiphoid, linea alba, pubis, pubic crest, anterior half of iliac crest, forming the inguinal ligament

### INTERNAL OBLIQUE

- **Origin:** lumbar fascia, anterior 2/3rds of iliac crest, lateral 2/3rds of inguinal ligament

- **Course:** passes upwards and forwards
- **Insertion:** lowest 6 costal cartilages, linea alba, pubic crest



- *The abdominal muscles*

## TRANSVERSUS ABDOMINIS

- **Origin:** lowest 6 costal cartilages, lumbar fascia, anterior 2/3rds of iliac crest and inguinal ligament
- **Course:** passes transversely, or like a fan
- **Insertion:** linea alba, pubic crest

## ABDOMINAL INCISIONS

1. **Midline:** through the linea alba. Bloodless, quick entry [emergency], easily extended but with a higher risk of hernias.
2. **Paramedian:** 2.5-4cm lateral to the midline, at the medial border of the rectus. The two layers of the sheath must be split. It is time consuming with considerably more blood loss, but easily extensible.
3. **Pararectal:** 5-6cm laterally, at the lateral border of the rectus. Has been abandoned as it causes muscle atrophy due to nerve severing.
4. **Transrectal:** 3-5cm laterally, splitting vertically the muscle fibers.
5. **Subcostal [Kocher]:** starts at the midline and passes inferolaterally, parallel to the costal margin and at a 2.5cm distance [to save the T9 nerve]
6. **Gridiron [McBurney]:** oblique at the McBurney point, muscle splitting
7. **Transverse incisions:** by splitting or cutting the muscles
8. **Oblique incisions:** i.e. Rutherford Morisson for renal transplants
9. **Thoracoabdominal:** midline which passes to the thorax through the 8<sup>th</sup> or 9<sup>th</sup> intercostal space.

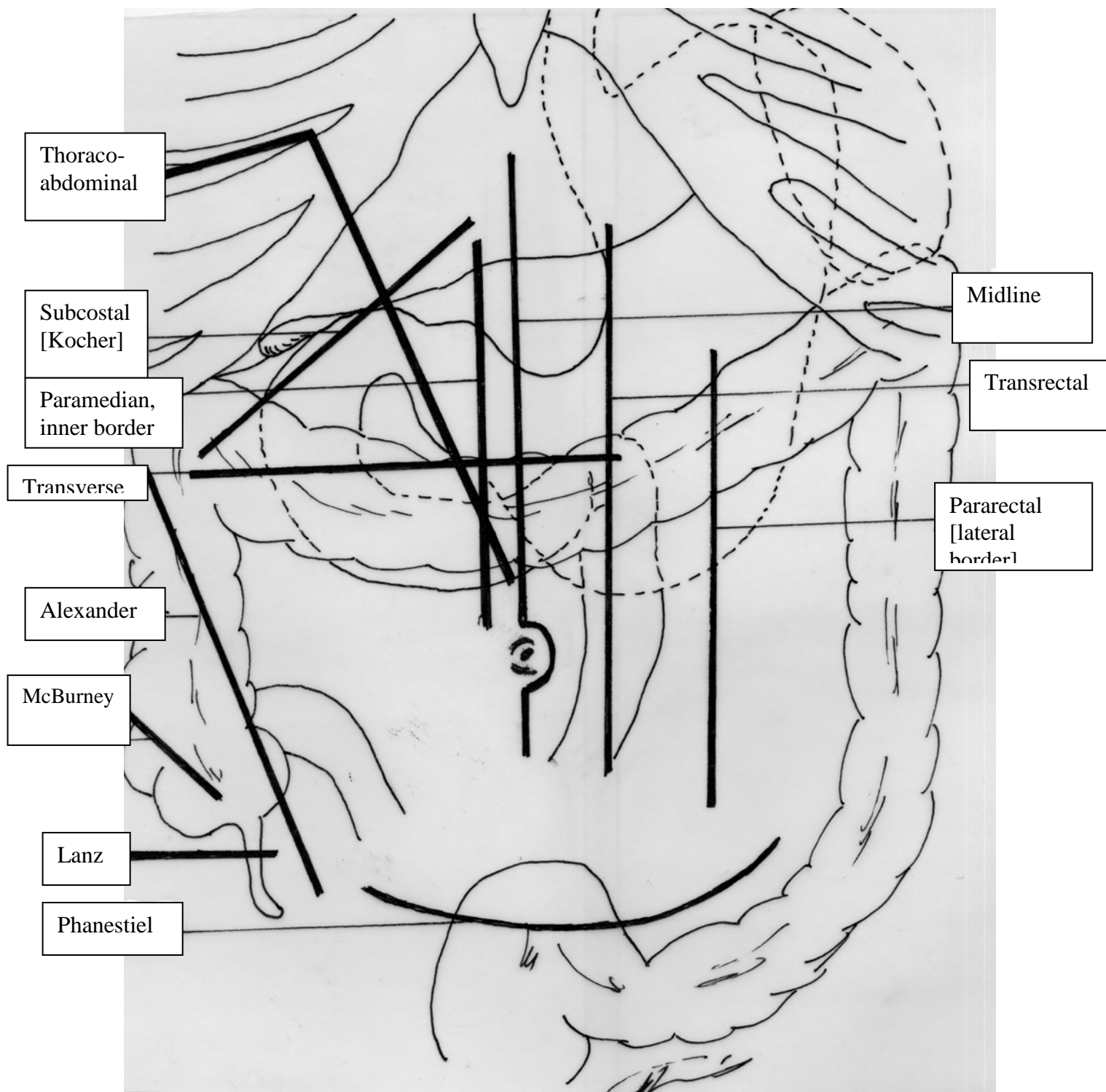
## THE INGUINAL CANAL

The **inguinal ligament** is formed by the inferior, under-turned fibers of the **external oblique aponeurosis**. It joins the **anterior superior iliac spine** to the **pubis**. At its medial end it forms **two crura**, one attached to the **pubic tubercle** and the other to the **pectineal line**, connected with the **pectineal ligament**. Its lateral [outer] surface forms the **lacunar ligament of Gimbernati**. The two crura are reinforced by **intercrural fibers**. The medial crus joins the **conjoint tendon** [fusion of internal oblique and transversus abdominis aponeuroses]

- **Superficial inguinal ring:** Triangular, V-shaped, formed by the two crura and the intercrural fibers. From this point starts the external spermatic fascia.
- **Internal [deep] ring:** lies a finger's breadth above the inguinal ligament, at the midinguinal point [where passes the femoral artery]. It is the point where the spermatic cord leaves the abdomen.
- **Inguinal canal** [4cm long]
- **Conveys:** **spermatic cord** or **round ligament** which spreads into strands as it approaches the labia major. A fat pad is closely applied to it.
- **ilioinguinal nerve**

- spermatic artery & veins or artery to the round ligament
- genital branch of the genitofemoral nerve
- **Boundaries:**

**Anteriorly:** external oblique aponeurosis, superficial fascia, fat, skin



*Laparotomies [incisions]*

- Posteriorly:** a. upper third [internal ring]: transversalis fascia up to where the inferior epigastric vessels pass medially  
 b. midthird: transversalis fascia, preperitoneal fat, peritoneum. The **Haselbach's triangle** is formed by the inferior epigastric vessels, the inguinal ligament, the pubic tubercle and the rectus sheath. It is the point that direct hernias protrude.  
 c. lower third: transversalis fascia laterally, reflected inguinal ligament [Cooper] fusing with the conjoint tendon medially.
- Above:** fibers of internal oblique and transversus abdominis
- Below:** inguinal ligament

## SPERMATIC CORD

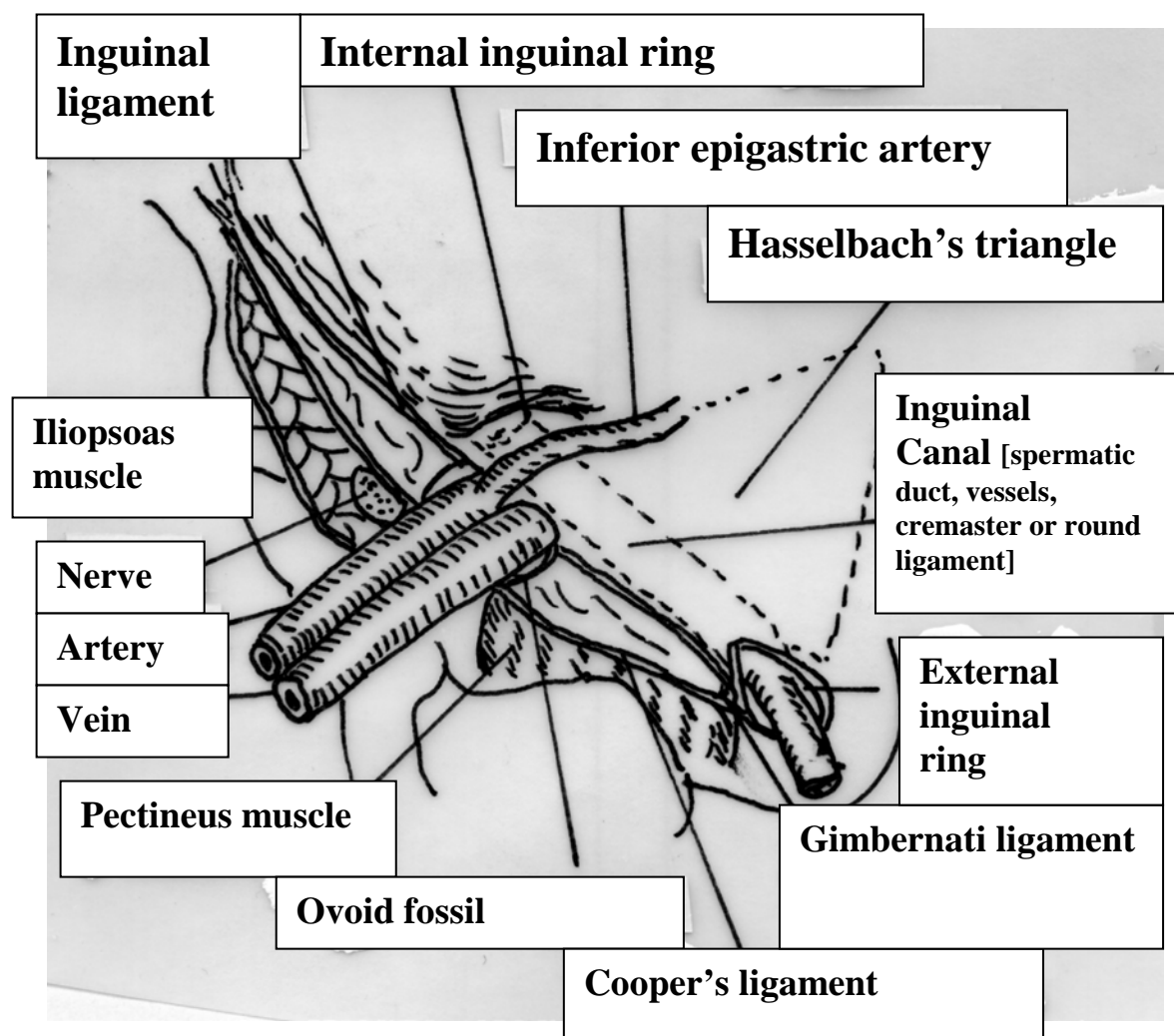
- 3 layers of fascia:** a. **External spermatic** [from external oblique aponeurosis]  
 b. **Cremasteric** [from internal oblique & fibers of the cremaster muscle]  
 c. **Internal spermatic** [from transversalis fascia]
- 3 arteries:** 1. **Testicular** [from internal spermatic, branch of the aorta]  
 2. **Cremasteric** [from inferior epigastric, branch of the external iliac]  
 3. **Artery of the vas deferens** [from inferior vesical artery, branch of internal iliac]
- 3 nerves:** a. **nerve to the cremaster** [genitofemoral]  
 b. **sympathetic fibers**  
 c. **ilioinguinal nerve**, lateral to the cord. [ the iliohypogastric nerve lies superiorly and medially but NOT in the cord]
- 3 other structures:** 1. **Vas deferens**  
 2. **Pampiniform plexus** [a venous plexus forming the testicular or internal spermatic vein, which drains the R testis to the IVC and the L to the Left renal vein]  
 3. **Lymphatics**, draining to the preaortic nodes

## LAYERS OF TESTIS & SCROTUM

### 8 coverings

1. **Tunica vaginalis** [derived from the invaginated peritoneum]
2. **Preperitoneal fat** layer
3. **Internal spermatic fascia** [from transversalis fascia]
4. **Cremasteric fascia** [from internal oblique & cremaster muscle]
5. **External spermatic fascia** [from external oblique]
6. **Dartos Tunic: Colle's fascia** [superficial fatty layer of superficial somatic fascia]
7. **Dartos muscle** [smooth muscle]
8. **Skin**





*Anatomy of the inguinal canal in males [In the female, the round suspensory ligament of the uterus, instead of the spermatic cord, runs through it].*

# PERITONEAL CAVITY

## PERITONEUM

The peritoneal cavity is lined by the **parietal peritoneum**, a mesothelial lining. Whenever reflected onto the intraabdominal organs is called **visceral peritoneum**. The visceral peritoneum has **autonomic innervation** and the pain from its irritation is reflected to the midline, while the parietal has **somatic innervation** and the pain is localised.

### EMBRYOLOGY

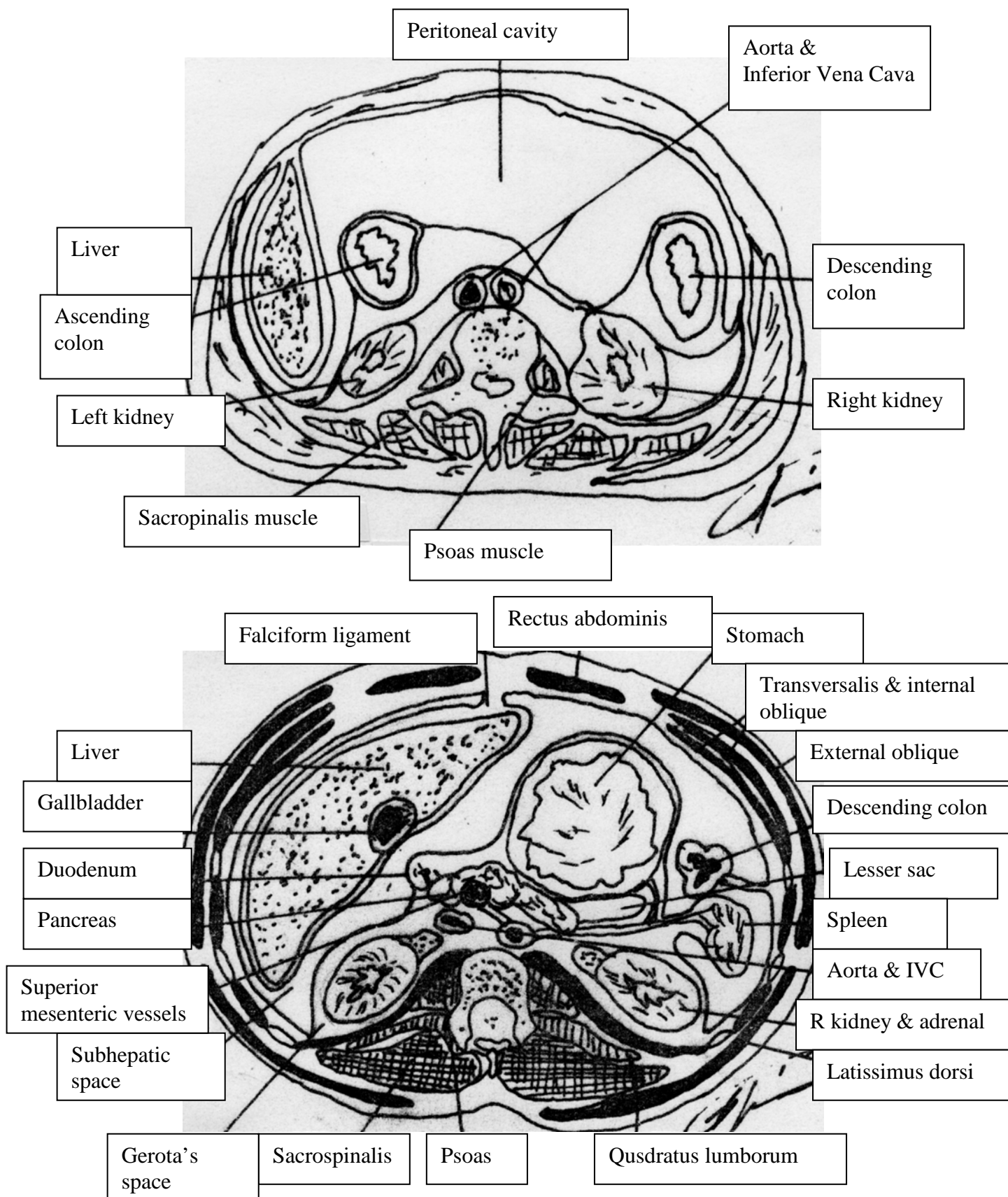
The endothelial lining of the **primitive coelomic cavity** of the embryo becomes the **thoracic pleura** and the **peritoneum**. As the viscera grow they produce invaginations of the peritoneum within its cavity.

- **REMNANTS**

- a. **Median umbilical cord** [urachus to bladder]
- B. **Lateral umbilical cord** [umbilical arteries]
- c. **Ligamentum teres** [foetal umbilical vein, attached to the liver]

### ANATOMY

- **Falciform ligament**, **coronary** and **triangular liver ligaments** attached to the lateral abdominal wall and the diaphragm are condensations of the peritoneum which encloses the liver, leaving a **bare posterior area**.
- The peritoneum descends from the **porta hepatis** as a **double sheet**, the **lesser sac**, splits to enclose the **stomach**, loops downwards to the **transverse colon** and the **great omentum**.
- The **transverse mesocolon** is covered by the two sheets and forms the floor of the lesser sac.
- The **mesentery** forms the floor of the **great sac** and covers the **abdominal viscera**.
- **Intraperitoneal fossae:**
  - **Lesser sac**
  - **Retrocecal fossa**
  - **Intersigmoid fossa**
  - **Paraduodenal fossa**
- **LESSER SAC:** A pouch behind the stomach and lesser omentum. On the left the boundary is the spleen, attached to the stomach by the **gastrosplenic ligament** and to the abdominal wall with the **lienorenal ligament**. On its right is the left lobe of the liver and communicates with the great sac through the **foramen of Winslow**. Superiorly lie the liver and the diaphragm, inferiorly the transverse mesocolon. On its floor lie the oesophagus and the pancreas.
- **Subphrenic spaces [Potential]**
  - **Right subphrenic**
  - **Left subphrenic**
  - **Right subhepatic [Morrison's pouch]**
  - **Left subhepatic**



• *Transverse view of the abdomen. Upper: level T12 -L1, Lower: L2-L3*

## THE GASTROINTESTINAL TRACT

### DEVELOPMENT OF THE INTESTINE

Three buds develop from the primitive **endodermal tube**:

- a. **Foregut** [stomach and 2/3rds of duodenum]
- b. **Midgut** [duodenum to distal transverse colon]
- c. **Hindgut** [splenic flexure to mucocutaneous junction]

There is a rapid proliferation of the gut wall resulting, initially in **obliteration** of the lumen which later **recanalizes** [failure to do so results in **atresia or stenosis**]

- **THE FOREGUT** rotates to the right as the lesser sac develops [the vagi follow], a process called **zygosis**, by which it blends with the posterior peritoneum.
- **THE MIDGUT** enlarges rapidly and forwards anteriorly; its middle is connected to the **vitello intestinal tract**. The cephalic [proximal] part forms the small intestine while the caudal [distal] forms the rest of the midgut. Just distal to the connection with the duct and to its right a bud develops which will become the cecum. As the midgut enlarges it herniates into the umbilical cord, having as its axis the superior mesenteric artery. At 10 weeks the midgut begins to return into the abdominal cavity and **rotates 90°**, so that the cephalic limb lies to the right and the caudal to the left; the caudal limb then returns [lying superficially] while the cecum descends to the right iliac fossa.

### ANOMALIES

1. **Atresia or stenosis**: failure of recanalization
2. **Meckel's diverticulum**: It represents the remnants of the vitello-intestinal tract. Is in the antimesenteric border of the ileum, usually at **60cm from the ileocecal valve** [range 15-350cm] and is 3-5cm long. Occurs in 2% of subjects and the male: female ratio is 2:1. It may contain islets of **oxyntic peptic cells** [→ haemorrhage] and may present macroscopically as:
  - a. **diverticulum** [with or without a band filament connecting it to the umbilicus]
  - b. **fistula** [to the umbilicus]
  - c. **fibrous band** to the umbilicus
  - d. **cyst** within a fibrous tract or at the umbilicus
3. **Malrotation**: the midgut does not rotate, so the cecum is at the left iliac fossa
4. **No descend of the cecum**: it often results in neonatal intestinal obstruction [**volvulus neonatorum**] due to passage of the peritoneal fold that normally seals the cecum in the right iliac fossa across the duodenum; the cecal mesentery is left as an arrow pedicle allowing volvulus.
5. **Reversed rotation**: the transverse colon lies behind the superior mesenteric artery and the duodenum in front of it.
6. **Exomphalus**: persistence of the midgut herniation.

### STRUCTURE OF THE GASTROINTESTINAL TRACT

**mucosa**

**submucosa**

**muscle coat** [muscularis propria]