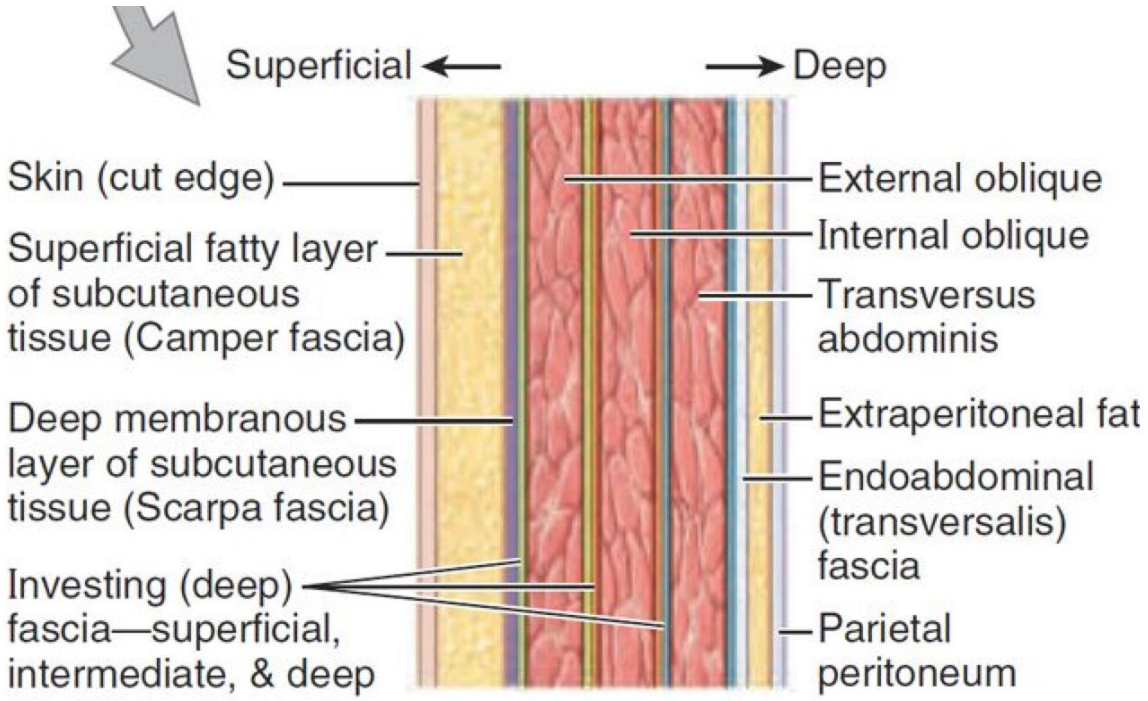
Anterior Abdominal Wall

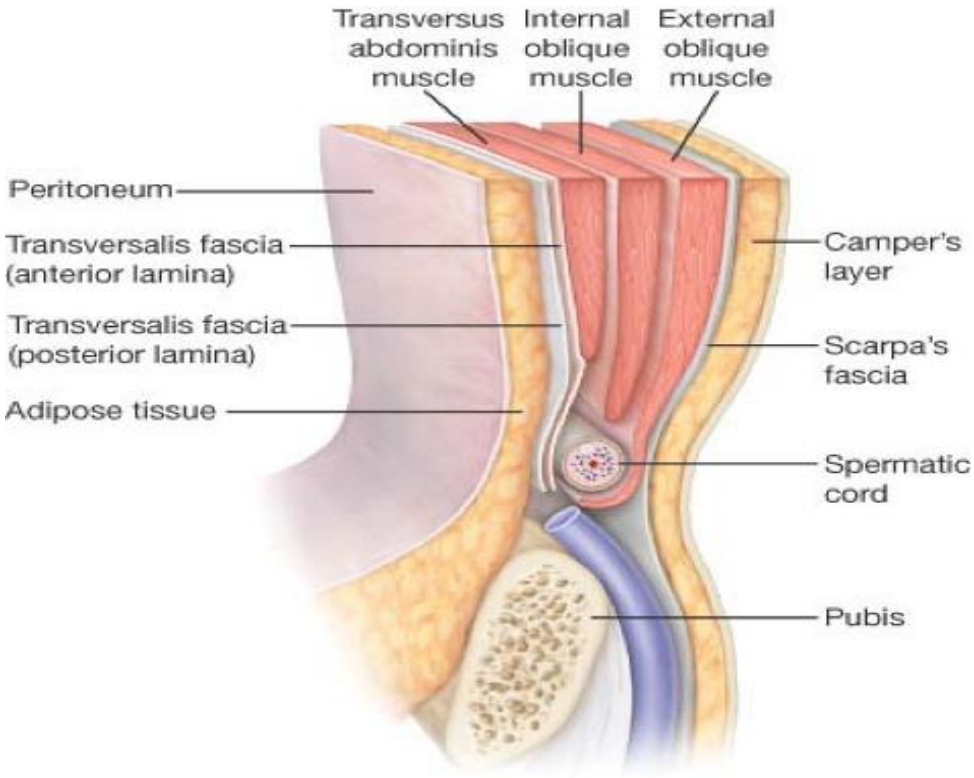
★ **Structures:** It is formed of the following layers:

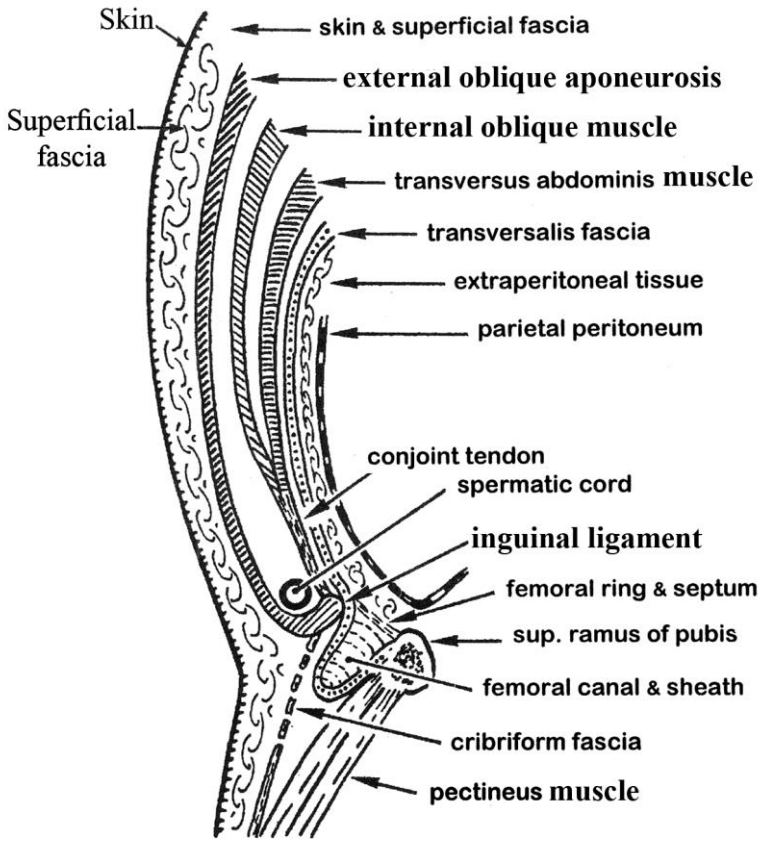
1. Skin
2 &3. Superficial fascia (no deep fascia).
4-6. Abdominal muscles.
7. Fascia transversalis
8. Extra-peritoneal fat.
9. Parietal peritoneum.



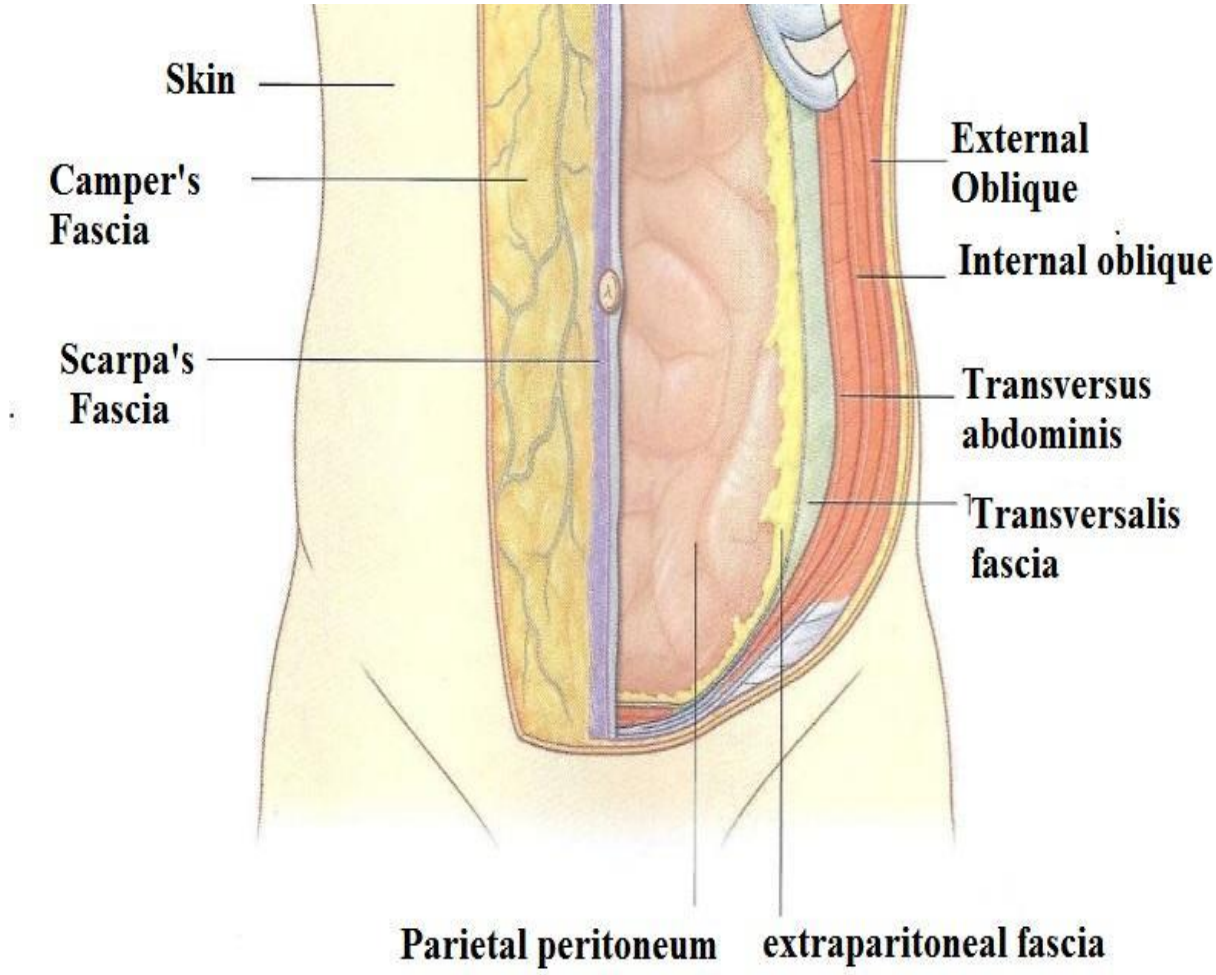
(B) Longitudinal section

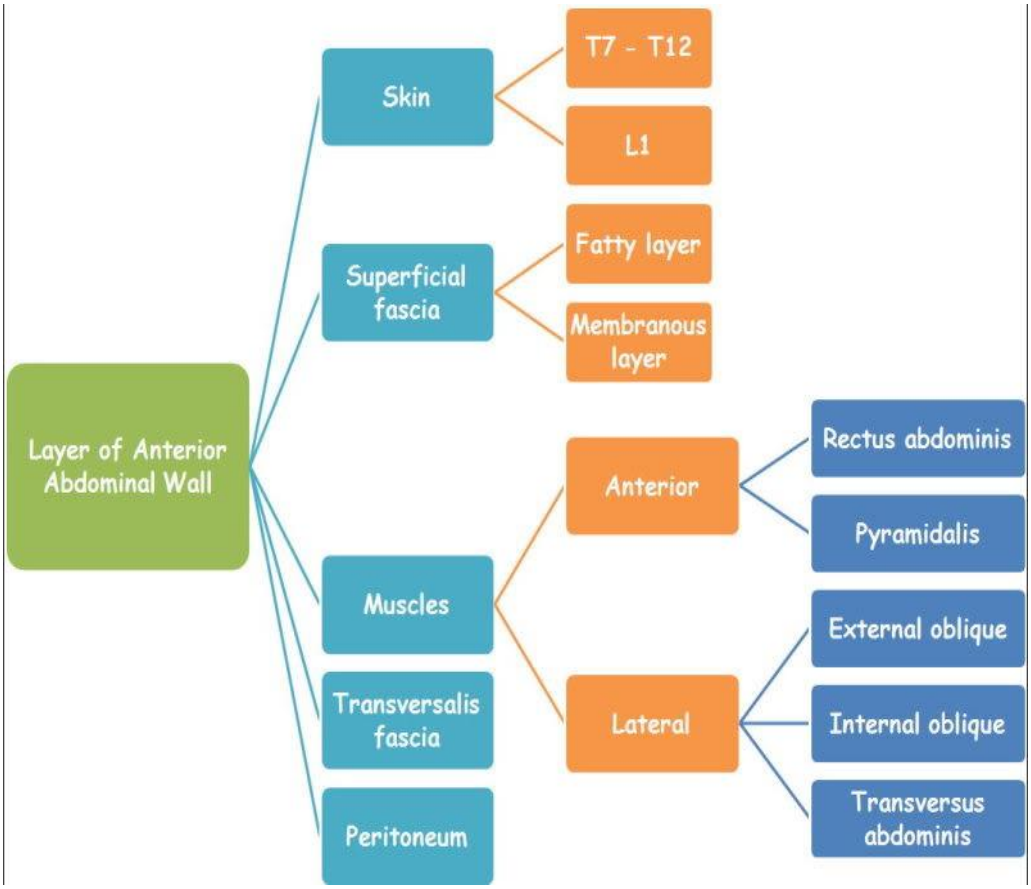
Layers of anterior abdominal wall





Layers of the anterior abdominal wall
(Longitudinal section at the level of femoral sheath)

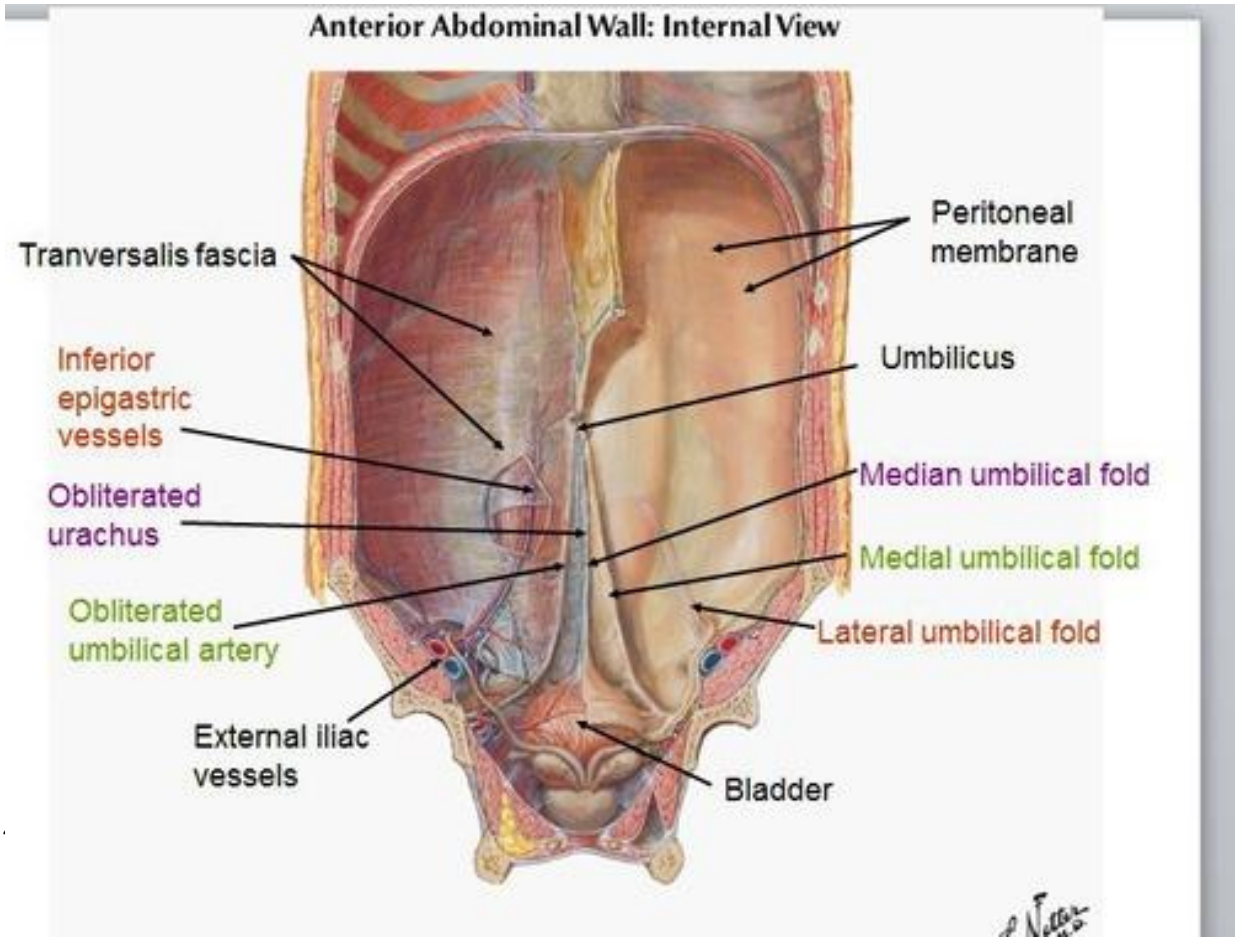

Skin
Camper's Fascia
Scarpa's Fascia
External Oblique
Internal oblique
Transversus abdominis
Transversalis fascia
Parietal peritoneum
extraparitoneal fascia


Layer of Anterior Abdominal Wall
Skin
T7 - T12
L1
Superficial fascia
Fatty layer
Membranous layer
Muscles
Anterior
Rectus abdominis
Pyramidalis
Lateral
External oblique
Internal oblique
Transversus abdominis
Transversalis fascia
Peritoneum

Skin

- It is thin & presents the **umbilicus** which is **inverted** scar formed by separation of umbilical stump after birth.
- It lies in the linea alba at **variable level**. Usually it lies one finger below a point midway between the xiphoid process & symphysis pubis (disc between L $_{3\&4}$).
- Its level is one of the sites of **anastomosis** between S.V.C&I.V.C as well as porto-systemic anastomosis.
- It is **inverted** because its posterior surface of the umbilicus is the meeting of **falciform** ligament , ligamentum **teres** of liver (obliterated left umbilical vein) , right & left **medial umbilical** ligaments (obliterated umbilical arteries) & **median umbilical** ligament (obliterated urachus).

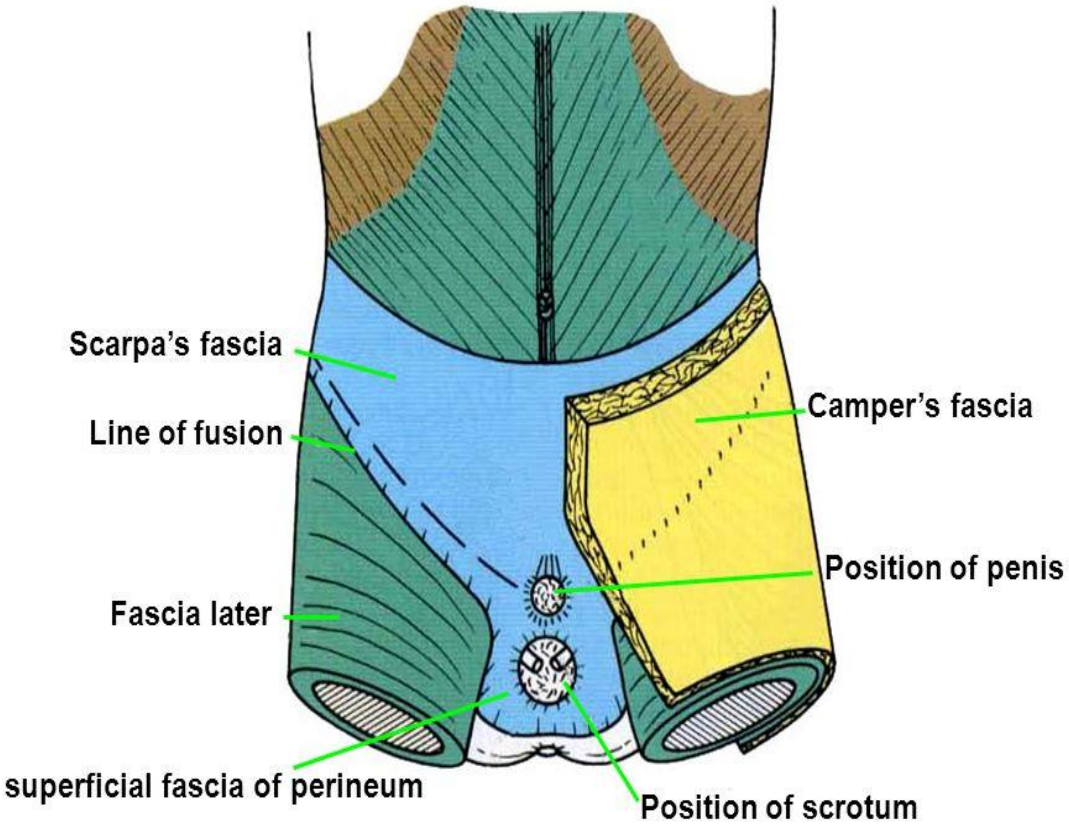
Structure attached to the posterior surface of the umbilicus



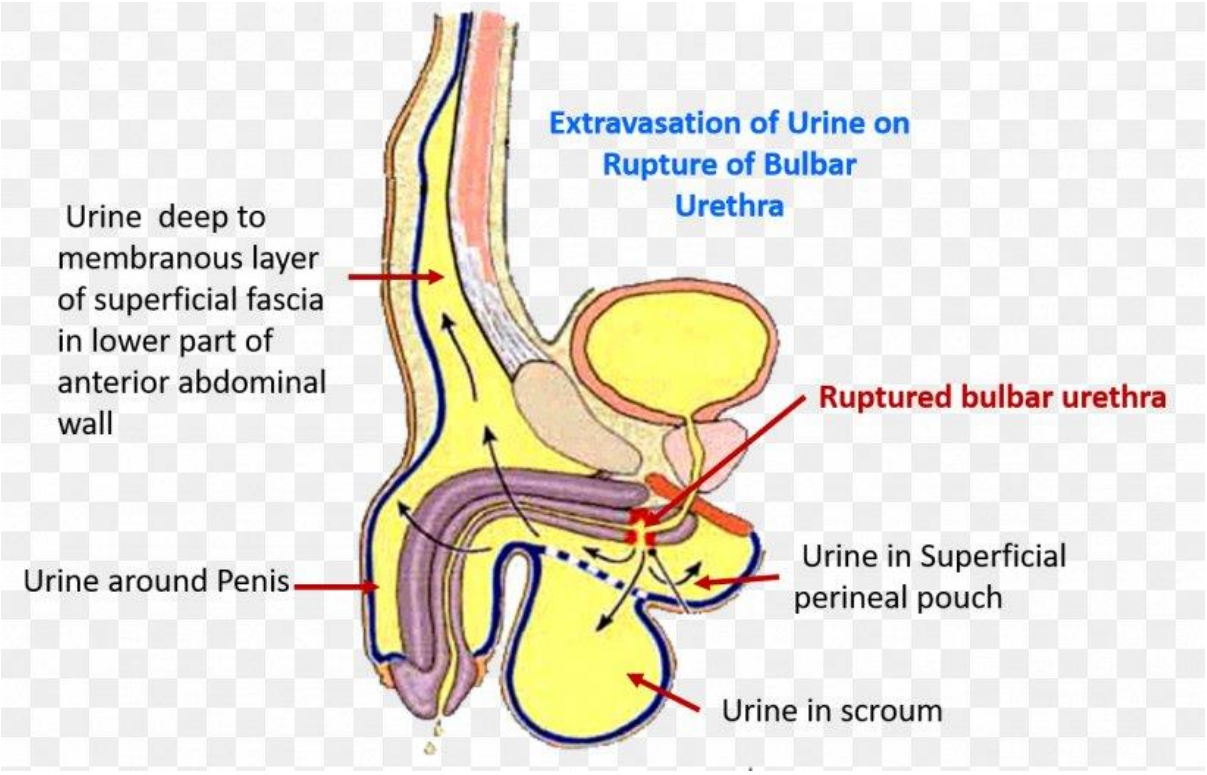
- **Above** the level of umbilicus the lymphatic & venous drainage pass upwards to the axilla while **below** this level they pass downwards to the groin .
- **Nerve supply**: Skin of anterior abdominal wall is supplied by T_{7-12} & L_1 nerves . Skin of at level of **umbilicus** is supplied by $\mathbf{T_{10}}$ (as the nerve supply of appendix) .

Superficial fascia

- It differentiates, particularly below the umbilicus, into 2 layers:
  - **a) Superficial fatty layer : (Camper's fascia)** which is a major site for **storage of fat** .
  - ***b)*** **Deep membranous layer**: **(Scarpa's fascia)**
    - It is well developed below the umbilicus .
    - **Laterally** , it is attached to the fascia lata of thigh below the inguinal ligament .
    - In the **median plane** , it envelopes the penis & scrotum then extends backwards into the perineum as Colle's Fascia which is attached to the posterior border of perineal membrane → superficial perineal pouch which contian buIbar urethra .
    - **Applied anatomy:** in extra-pelvic rupture of male urethra, extravasation of urine into the perineum, scrotum, penis and anterior abdominal wall (between Scarpa's fascia & abdominal muscles).

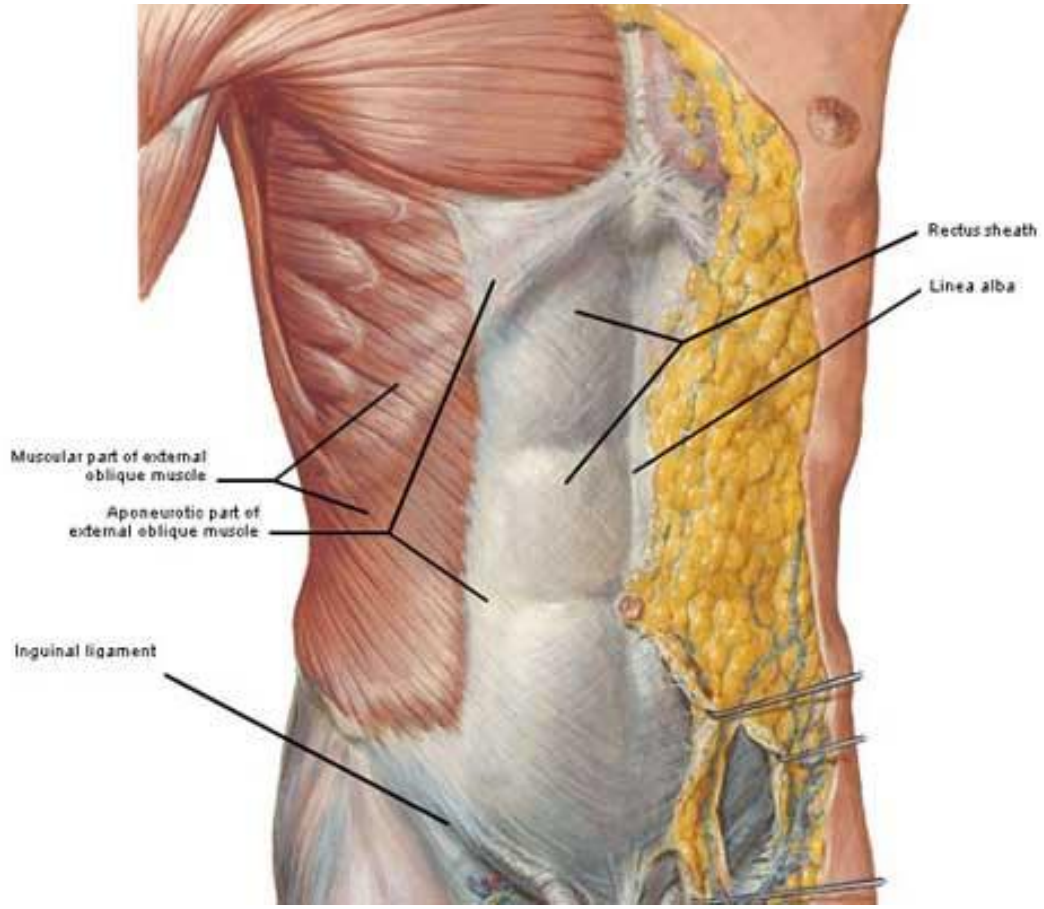


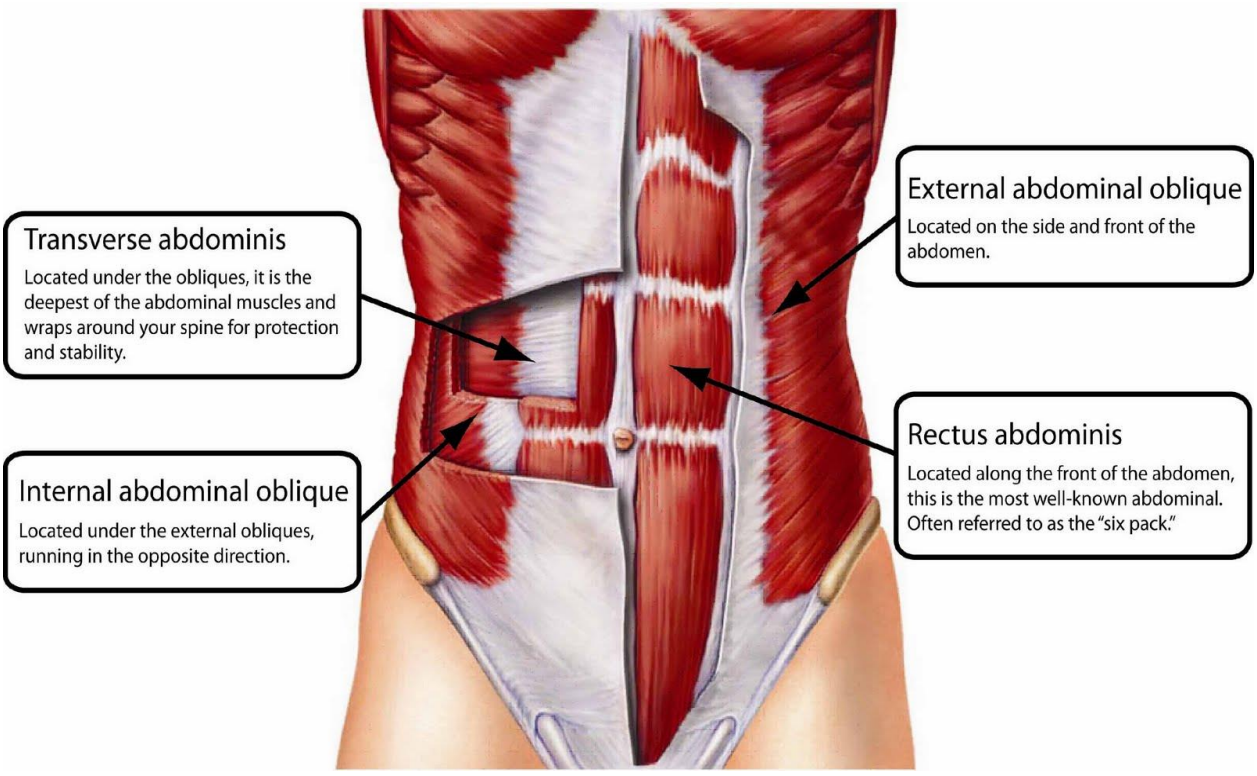
Scarpa's fascia



Muscles Of Anterior Abdominal Wall

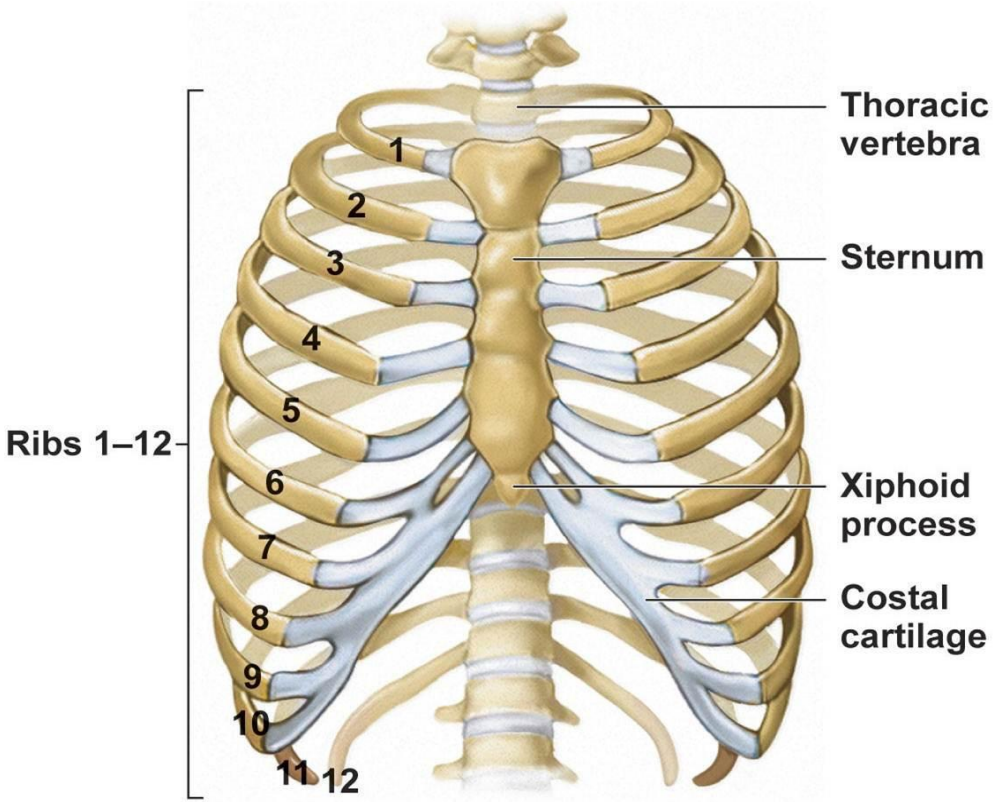
(See the table in the other file)

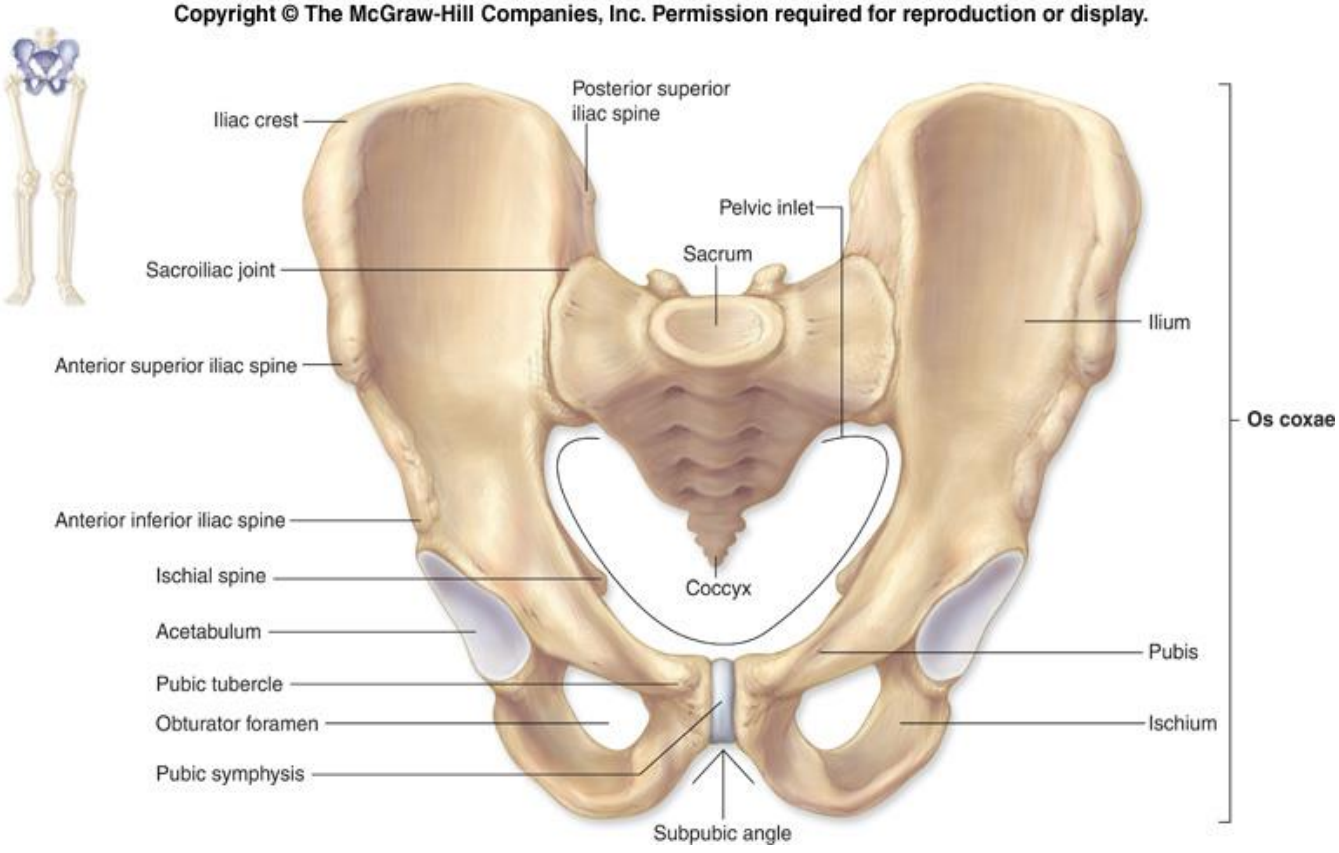


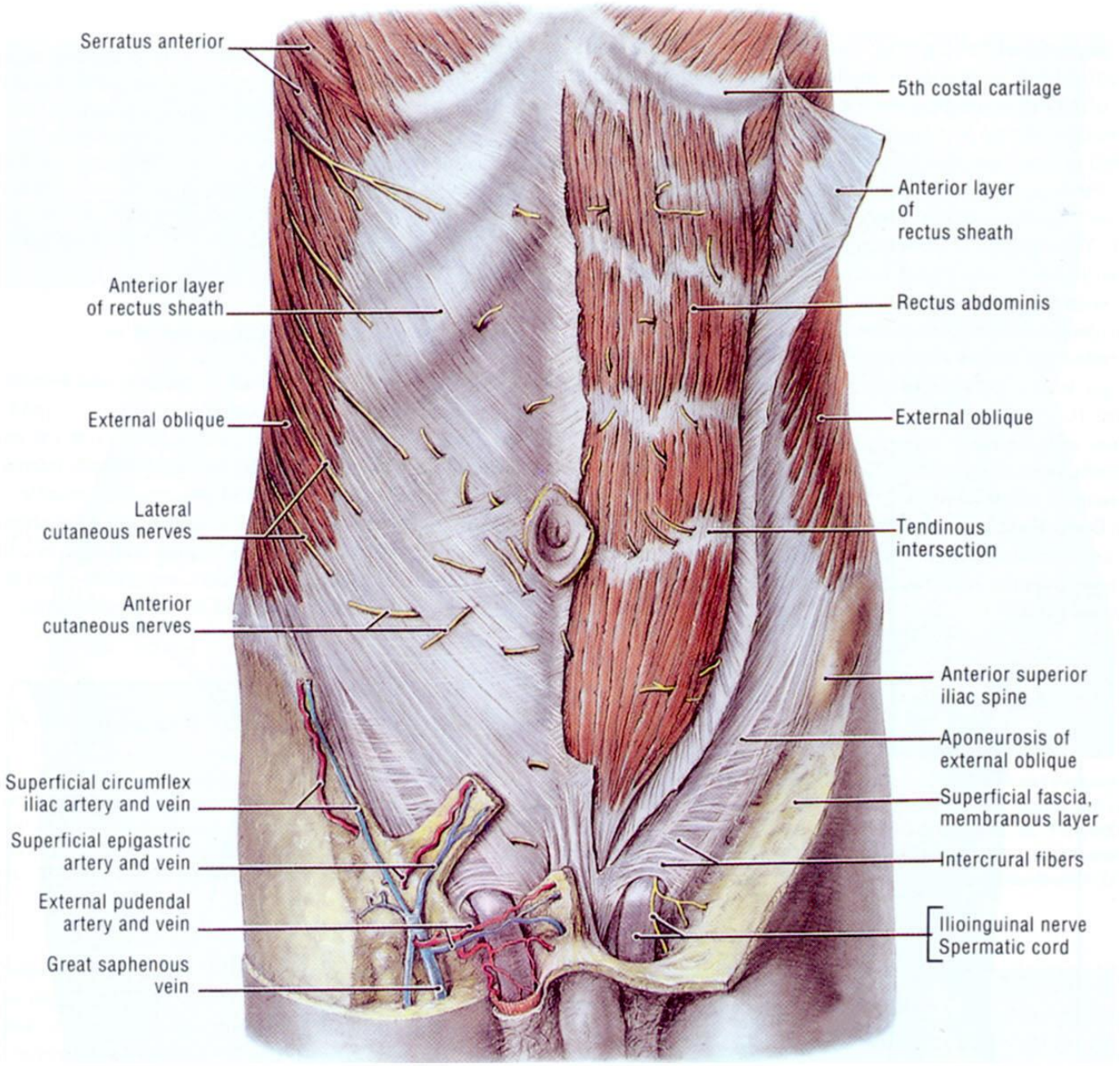


ORIGIN & INSERTION OF MUSCLES

OF ANTERIOR ABDOMINAL WALL

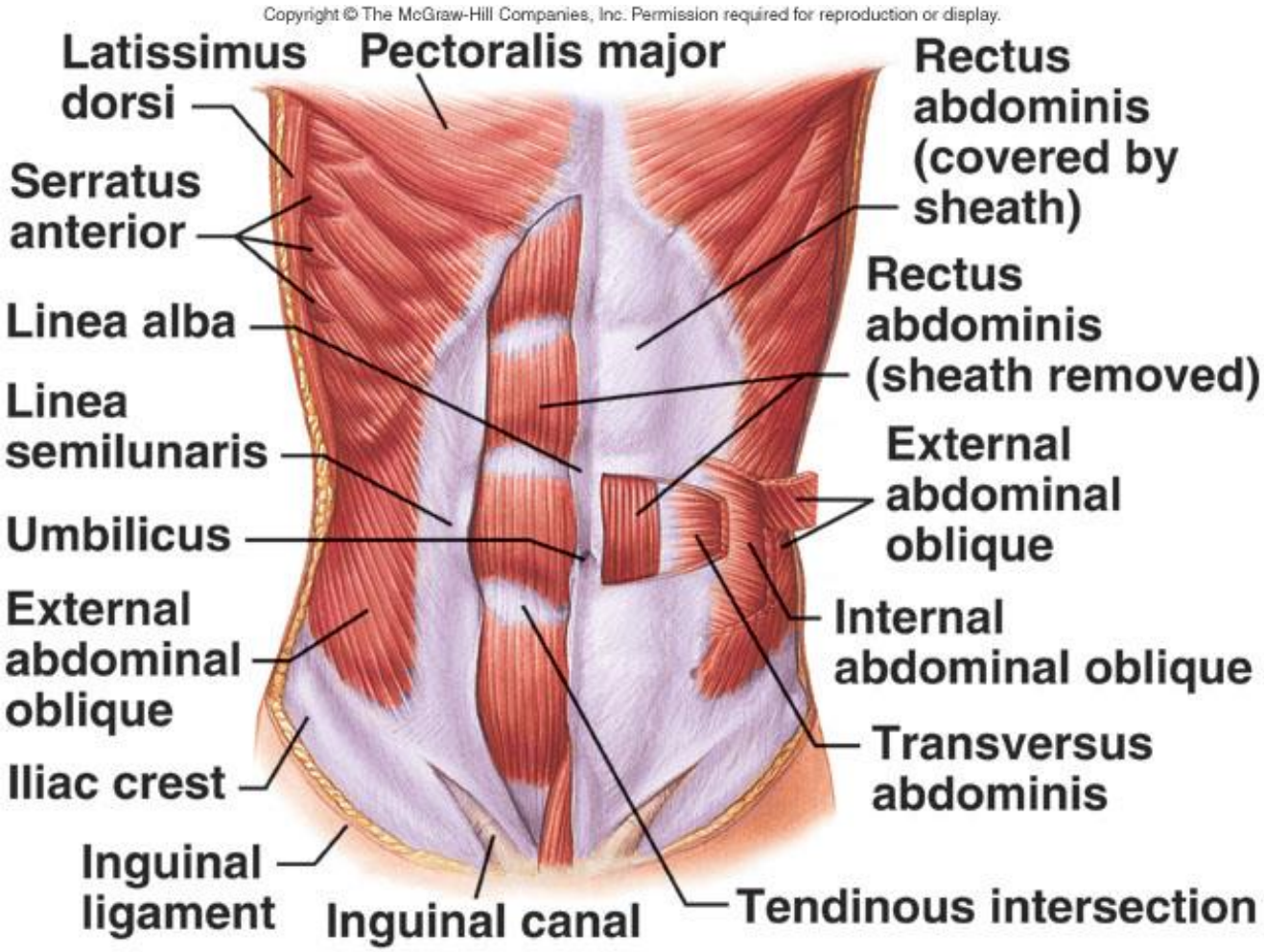






Muscles of anterior abdominal wall

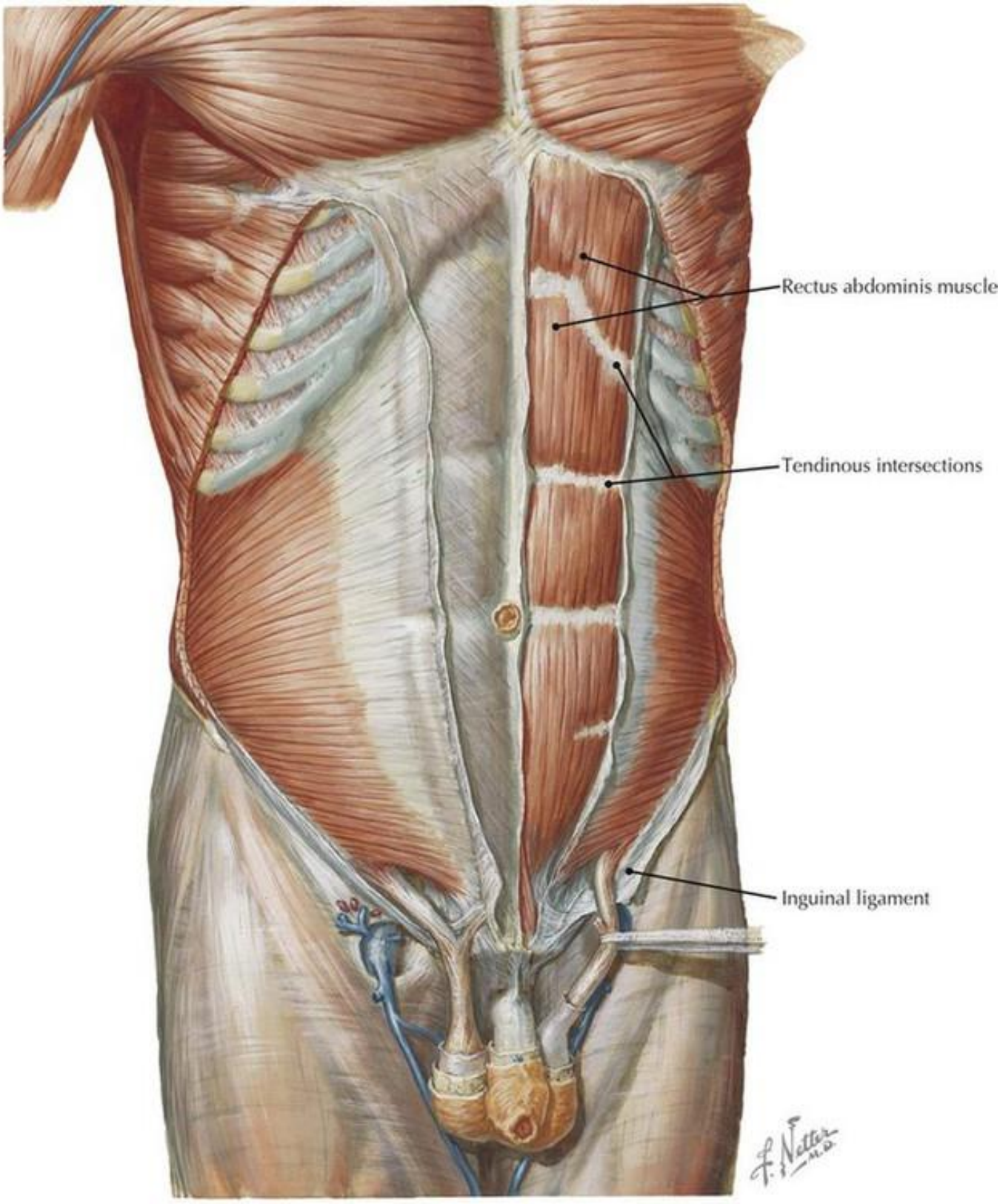
LUMBAR TRIANGLE OF **PETIT'S**



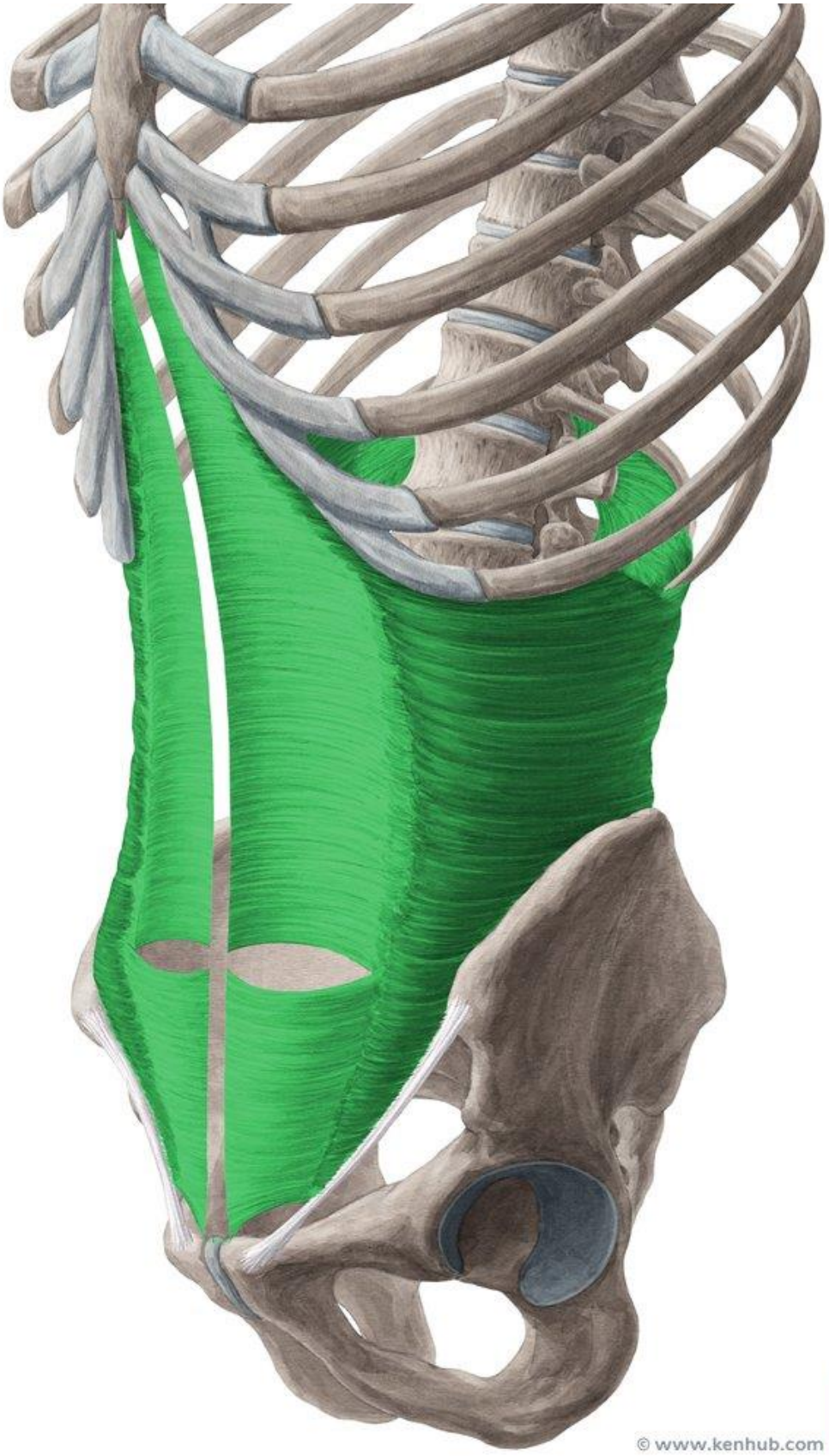
MUSCLES OF ANTERIOR ABDOMINAL WALL

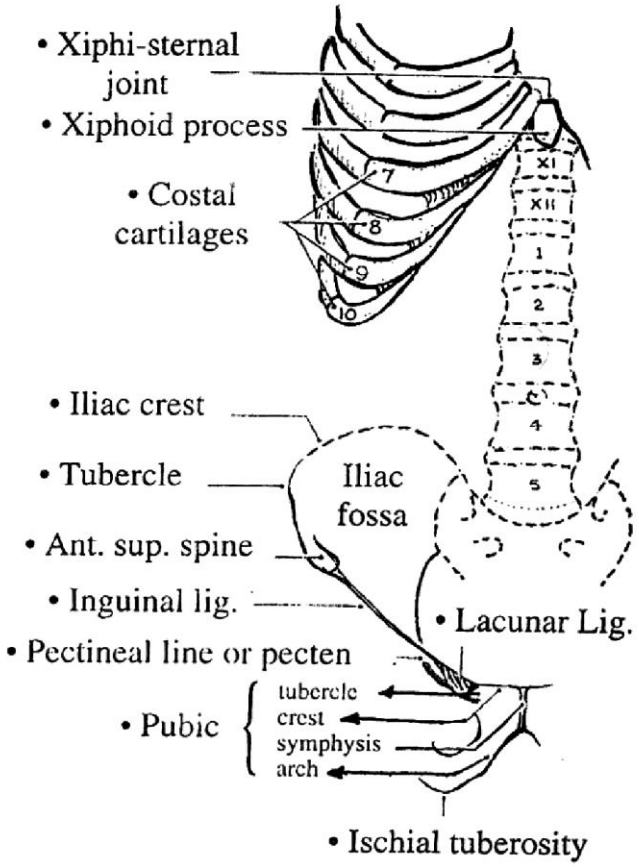
(External Abdominal Oblique & Rectus Abdominis muscles)

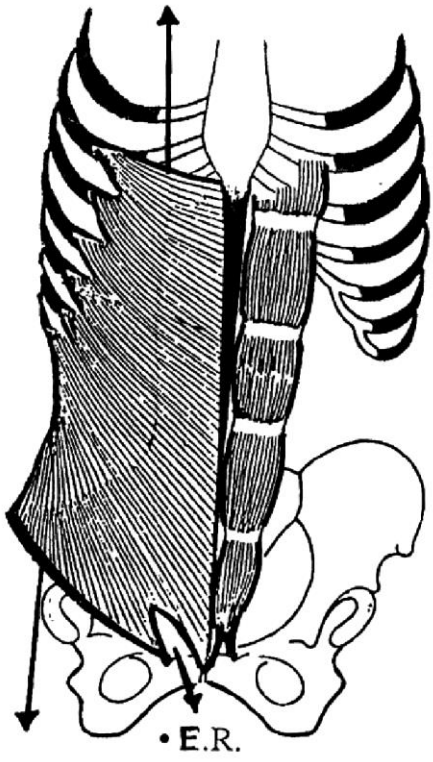
Internal abdominal oblique muscle



Transversus abdominis muscle

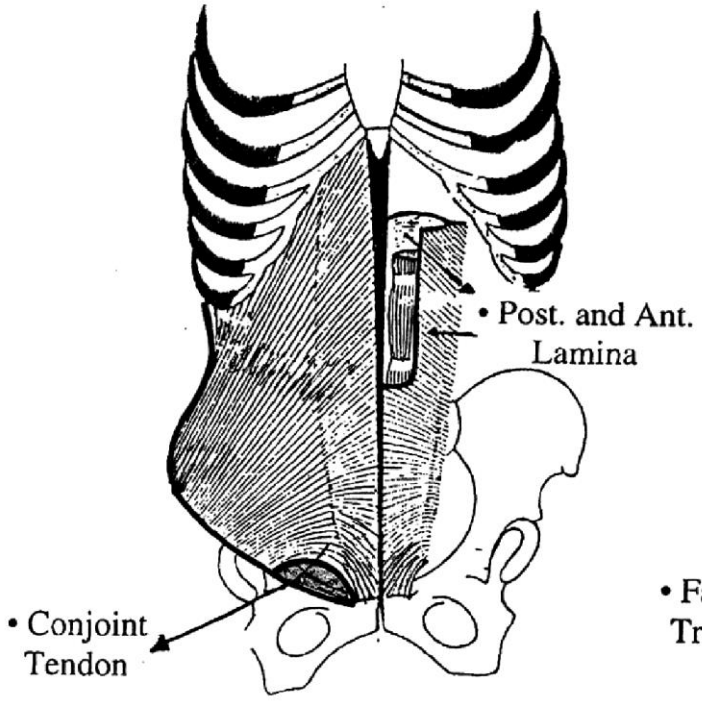




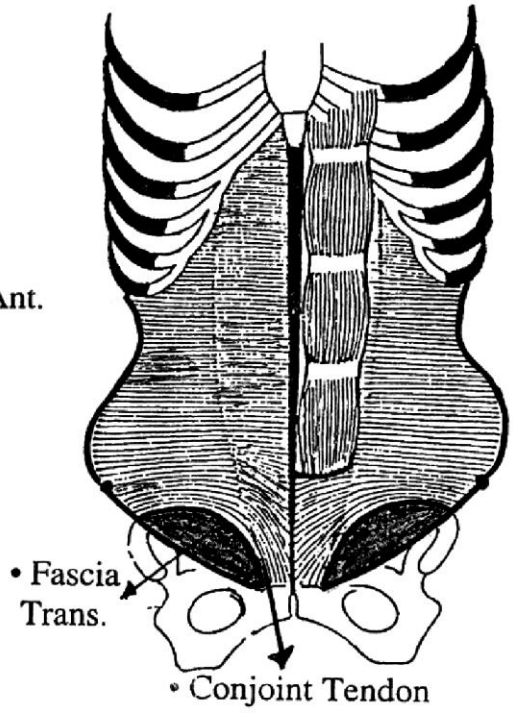


*** Ext. Abdominal Oblique ***

• Skeleton of Abdomen

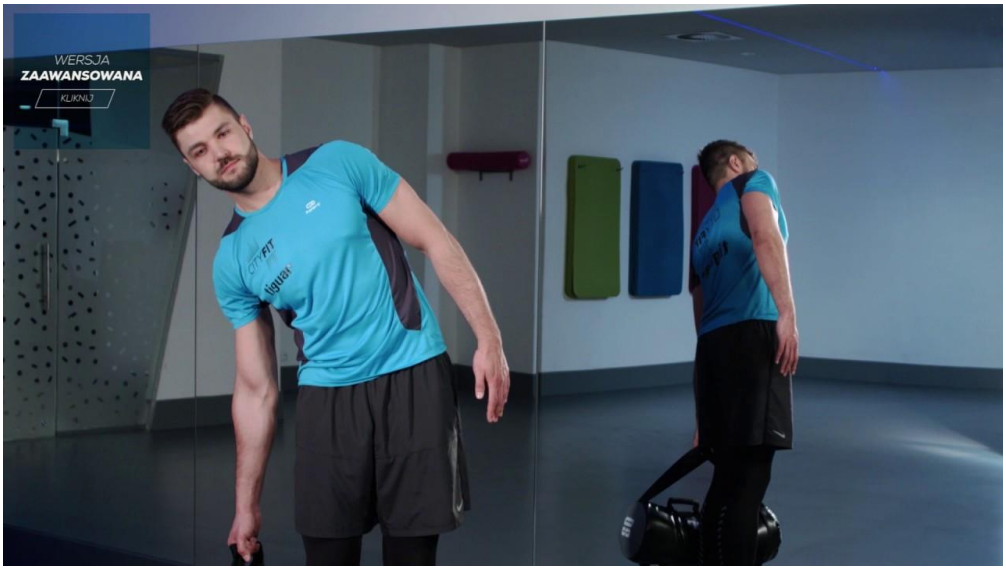


*** Int. Abdominal Oblique ***



*** Transversus Abdominis ***

Action of muscles of anterior abdominal wall



Lateral flexion

Lateral twist

Flexion of trunk (rectus abdominis

Linea alba

- It is a **strong raphe** (thin tendon) in the middle line of anterior abdominal wall between the 2 recti.
- It is **formed by** interlacing fibers of the 3 aponeuroses of the muscles of anterior abdominal wall (after forming the rectus sheath).
- It is attached between xiphoid process & symphysis pubis.
- **Above the umbilicus**, it is relatively wide (1cm). Normally, contraction of 2 recti $\rightarrow$ obliteration of linea alba.
- **Below the umbilicus**, it is a narrow line which can be identified by the insertion of pyramidalis muscles.
- It shows the **umbilical scar**.

Rectus sheath

★ It is a fibrous sheath formed by the aponeuroses of the lateral muscles of anterior abdominal wall.

★ **Formation:**

1. **Above the costal margin:**
   - **a- Anterior wall:** Aponeurosis of external abdominal oblique.
   - **b- Posterior wall:** Is deficient, the rectus muscle lies on 5, 6, 7 costal cartilages.
2. **From the costal margin to a point midway between umbilicus and symphysis pubis:**
   - **a- Anterior wall:** External oblique aponeurosis & anterior lamina of internal oblique aponeurosis.

b- Posterior wall: Posterior lamina of internal oblique aponeurosis & aponeurosis of transversus abdominis**.**

3. **Below a point midway between umbilicus & symphysis pubis:**

a- Anterior wall: Aponeuroses of 3 muscles of anterior abdominal wall.

b- Posterior wall: Is deficient, the rectus muscle lies on the transversalis fascia.

- The posterior wall of rectus sheath ends by forming arched border called ***arcuate line***.

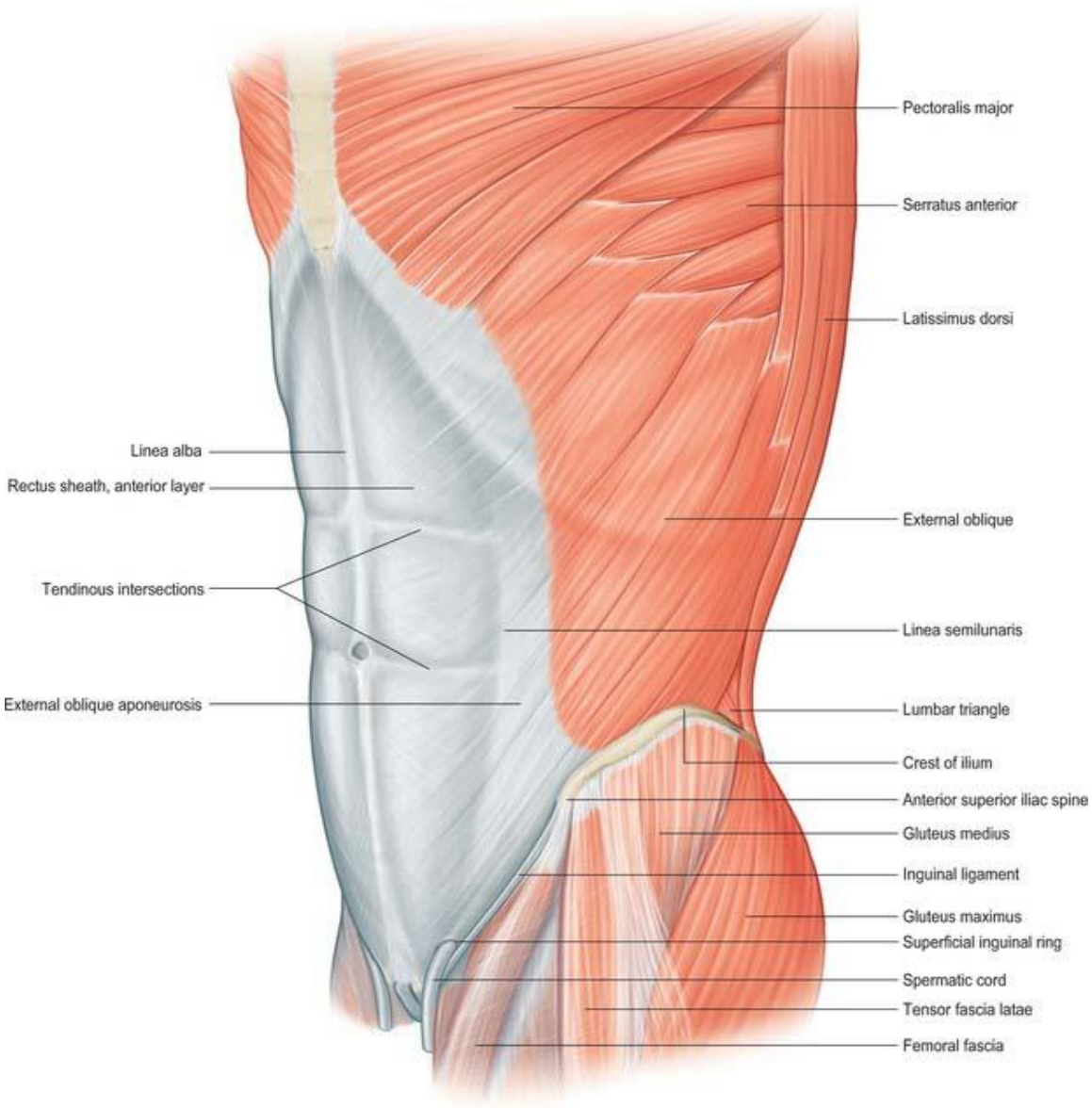
★ **Contents:**

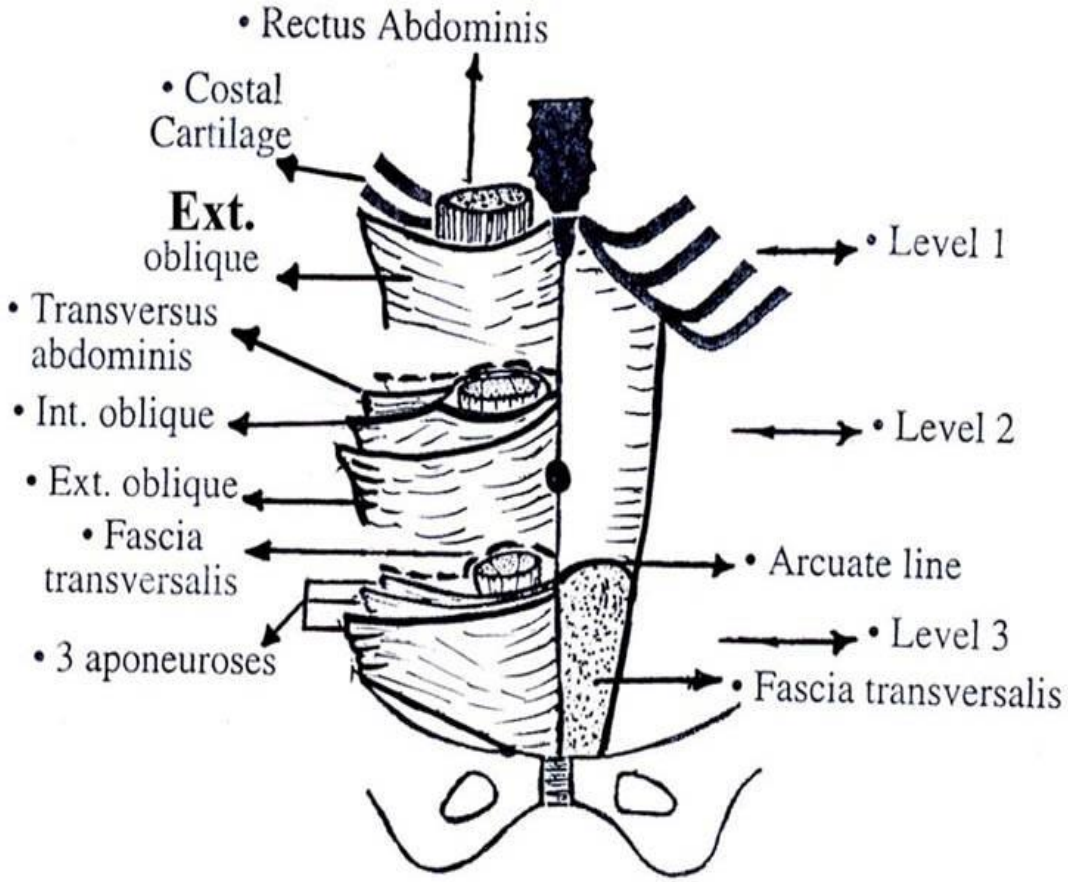
1) Rectus abdominis & pyramidalis (mention).
2) Superior & inferior epigastric vessels (mention).
3) Lower 5 intercostal & subcostal nerves & vessels: They pierce the posterior wall of rectus sheath near its lateral edge then pass medially within rectus muscle and end by piercing anterior wall of the sheath.
4) Lymph vessels.

★ **Applied anatomy:**

1) In **Paramedian abdominal incision**, the rectus muscle is retracted laterally to avoid injury of its neurovascular supply.
2) Malignant cells may spread from cancer breast in the lymphatics in the rectus sheath leading to malignant nodule in the umbilicus (**Sister Joseph nodule**).

External Abdominal Oblique & Anterior Wall of Rectus Sheath





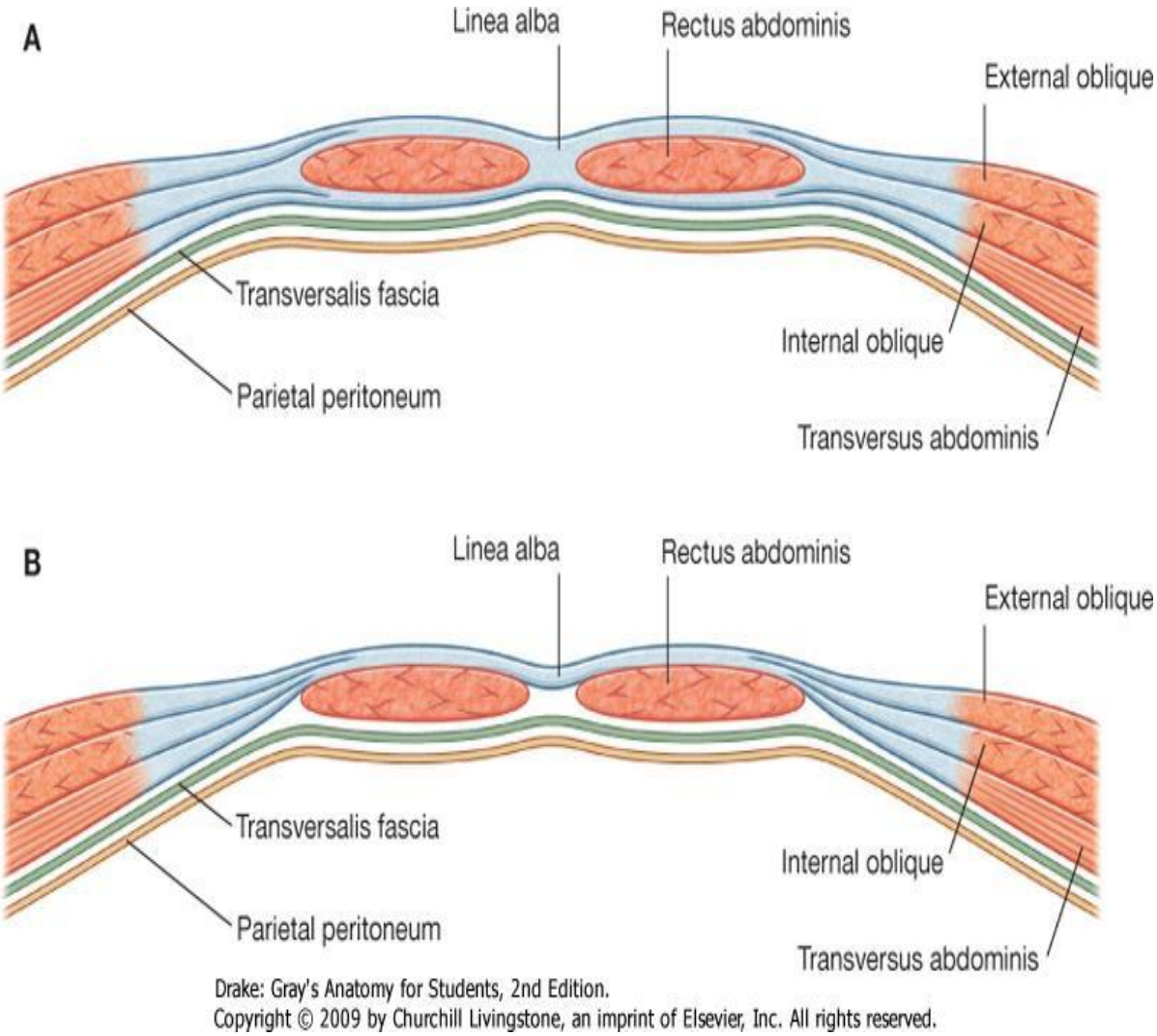
*** Rectus Sheath ***

Sister Joseph nodule

❋ T.S in the rectus sheath :

A. Above level of arcuate line

B. Below level of arcuate line



Endoabdominal Fascia

(Fascia transversalis)

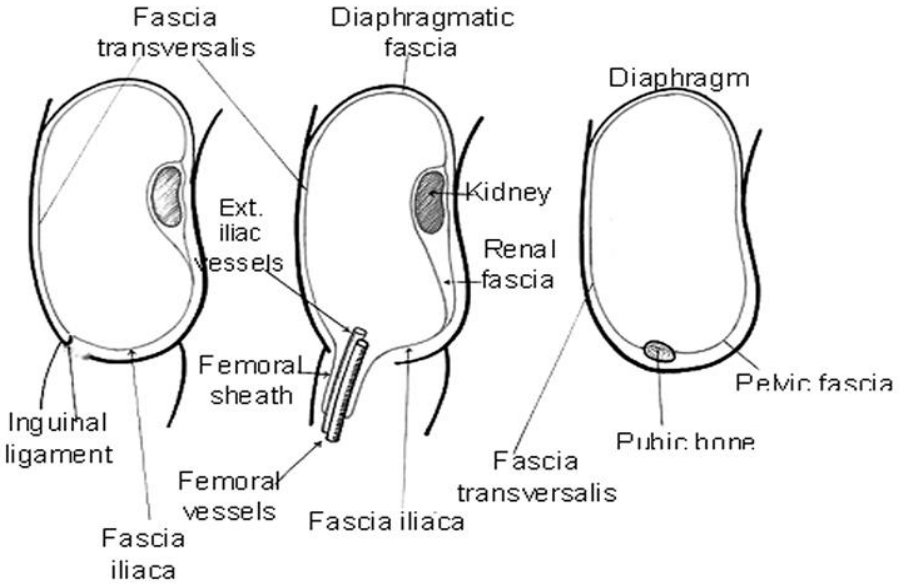
★ It is a thin fascia which lines the abdominal wall.

★ It is separated from parietal peritoneum by extra-peritoneal fat.

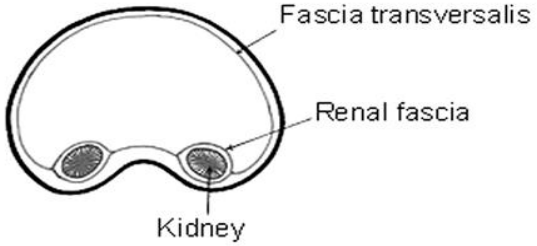
★ Extensions :

- Although continuous , it is named according to the muscle , aponeurosis or structure is related .
- **Above:** It is continuous with the fascia of diaphragm.
- **Posterior**: It enters in the formation of perirenal fascia.
- **Inferior:**
  - **a) Medial :** It is attached to pubic crest & medial part pectineal line and continues with the pelvic fascia lining the pelvic wall.
  - **b) Lateral:** It is attached to inner lip of iliac crest (and becomes continuous with the fascia iliaca covering iliacus muscle) & lateral 1/2 of inguinal ligament.
  - **c) Between a & b** is passed in the thigh to form the anterior wall of femoral sheath.
- **Internal (deep) inguinal ring** is an opening in the transversalis fascia. At the deep inguinal ring, the fascia transversalis prolonges around the spermatic cord as internal spermatic fascia.

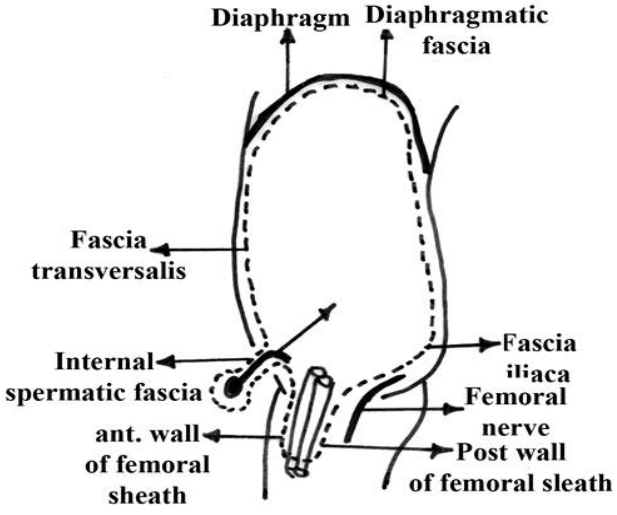
Saggital sections

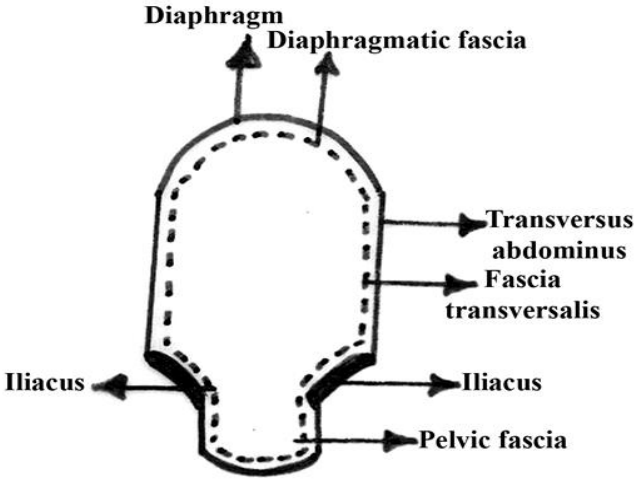


*** Laterally** *** In between** *** Medially**



Transverse section





Arteries of Anterior Abdominal Wall

I) Superficial arteries of the femoral artery:

a) **Superficial epigastric** artery.

b) **Superficial circumflex iliac** artery.

II) Deep arteries :

A) Above the umbilicus:

1. 2 Terminal branches of the internal thoracic artery:

b) Superior epigastric artery:

- It descends behind the 7th. costal cartilage to enters the rectus sheath to descend behind the rectus abdominis muscle to the level of the umbilicus where it anastomoses with inferior epigstric artery.

c) Musculo-phrenic artery:

- It runs downwards and laterally along the costal margin.

B) Below the umbilicus:

- **Branches of the external iliac artery:**

a) Inferior epigastric artery:

- **Origin**: it arises from external iliac artery just behind the inguinal ligament.
- **Course:**
  - It passes upwards and medially, **medial to the internal inguinal ring ,** passes in front of the arcuate line to enter the **rectus sheath** behind the rectus abdominis.
  - **Termination:** at the level of the umbilicus by anastomosing with superior epigastric artery.

> ➢ **Applied Anatomy: The inferior epigastric artery is medial to the neck of the sac of oblique inguinal hernia but lateral to that of direct inguinal hernia.**

- **Branches:**

1) Cremasteric artery:

- ➢ It **enters** the deep inguinal ring and passes as one of the contents of the spermatic cord to supply the cremasteric muscle.
- ➢ It ends by **anastomosing** with the testicular artery.

2) Pubic branch:

- ➢ It descends behind the lacunar ligament and superior pubic ramus to anastomose with the pubic branch of obturator artery.
- ➢ In 30% of cases, the obturator artery is absent and replaced by **abnormal obturator ortery** which is a large pubic branch of inferior epigastric artery.
- ➢ This abnormal obturator artery passes just behind the free sharp border of the lacunar ligament and **liable for injury during operation for femoral hernia.**

b) Deep circumflex iliac artery:

- **Origin:** it arises from **external iliac** artery just behind the inguinal ligament.
- **Course:**
  - ➢ It passes upwards and laterally behind the inguinal ligament to reach anterior superior iliac spine.
  - ➢ It **runs** on the inner lip of iliac crest where it pierces the

transversus abdominis to runs in the **neurovascular plane**.

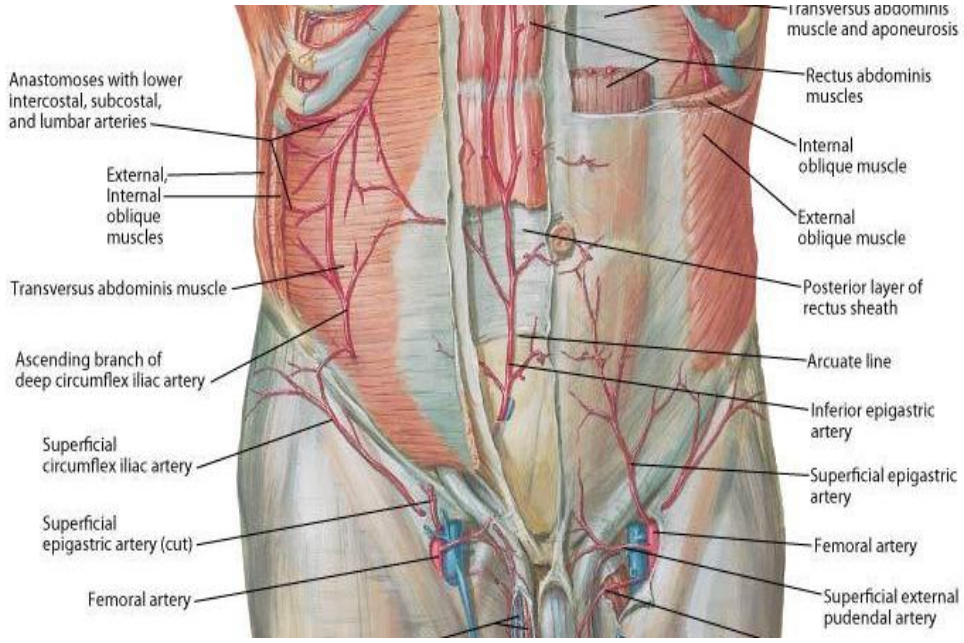
- **Branches:**
  1) **Muscular branches**
  2) **Anastomatic branches** sharing in the anastomosis around anterior superior iliac spine.
  3) **Ascending branch:** ascends to anastomose with the lumbar and musculophrenic arteries.

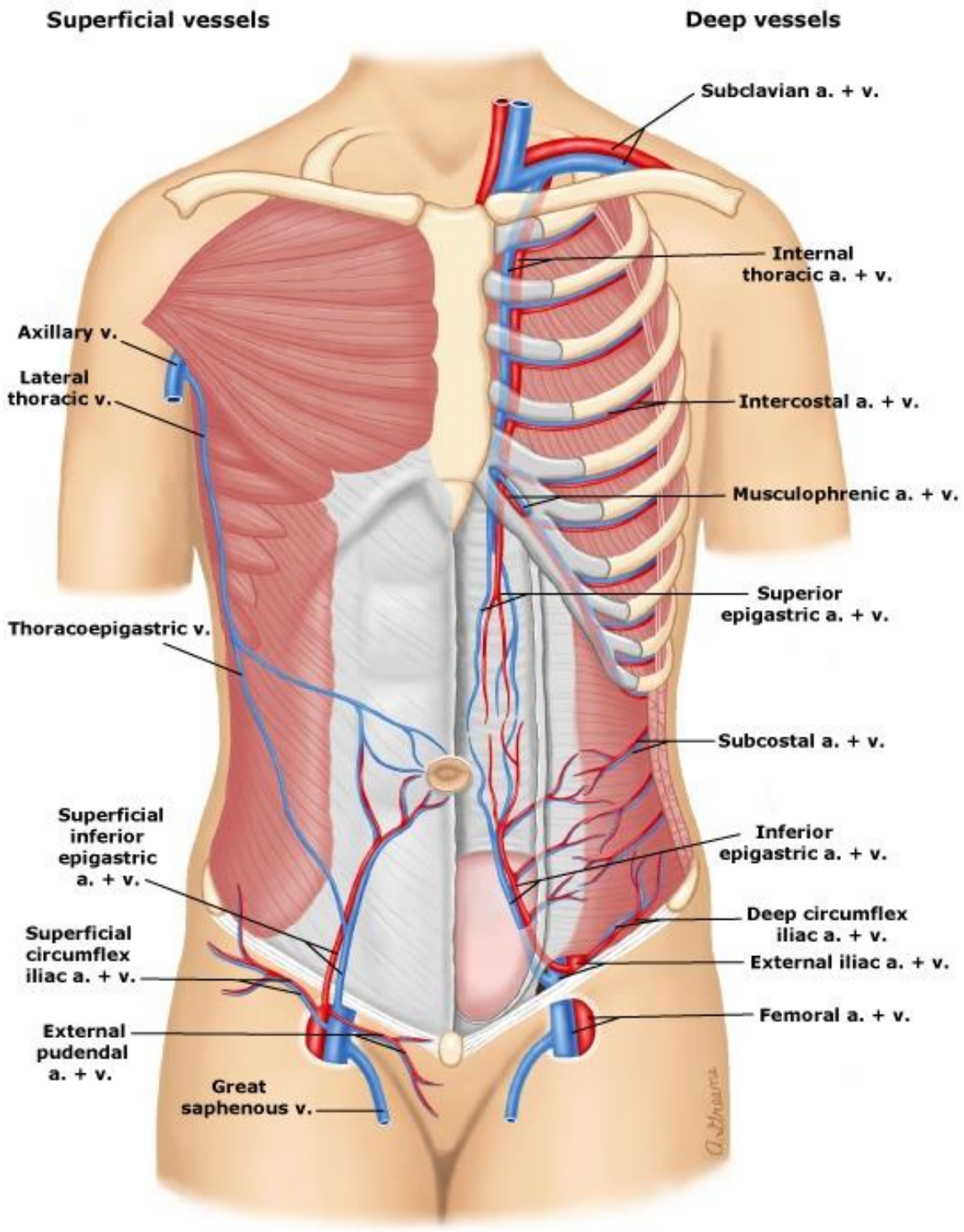
III) Lateral braches from aorta :

a) Lower 5 (7-11) posterior intercostal arteries and the subcostal artery are branches of the descending thoracic aorta.

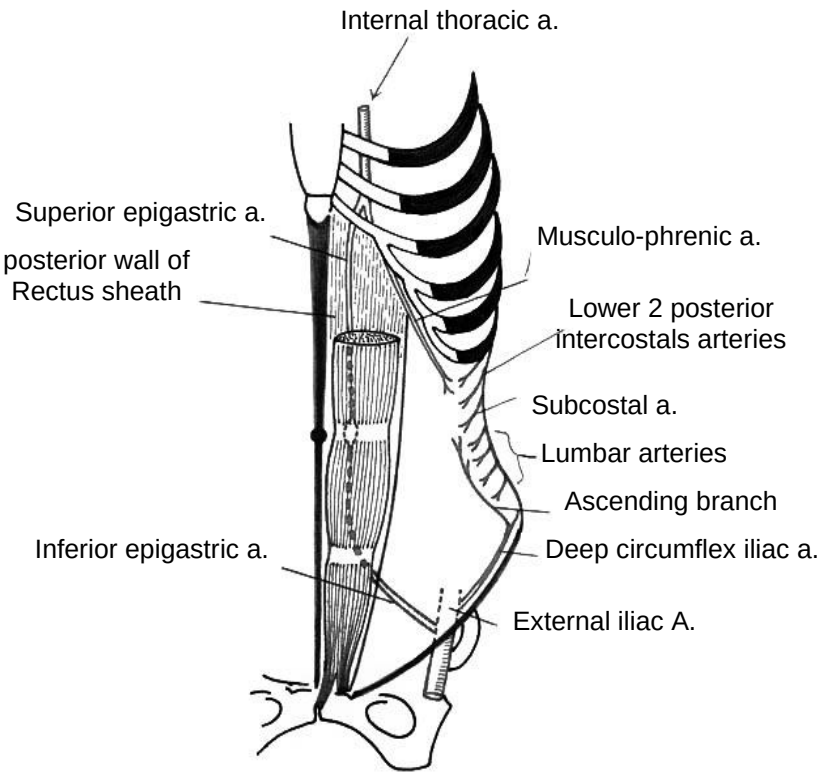
- They descend downwards and medially through the ***neuro-vascular plane*** between the internal oblique and the transversus abdominis to enter the rectus sheath.
- They pierce the posterior wall of rectus sheath near its lateral edge then pass medially within rectus muscle and end by piercing anterior wall of the sheath.

b) 4 Lumbar arteries: are branches of abdominal aorta.

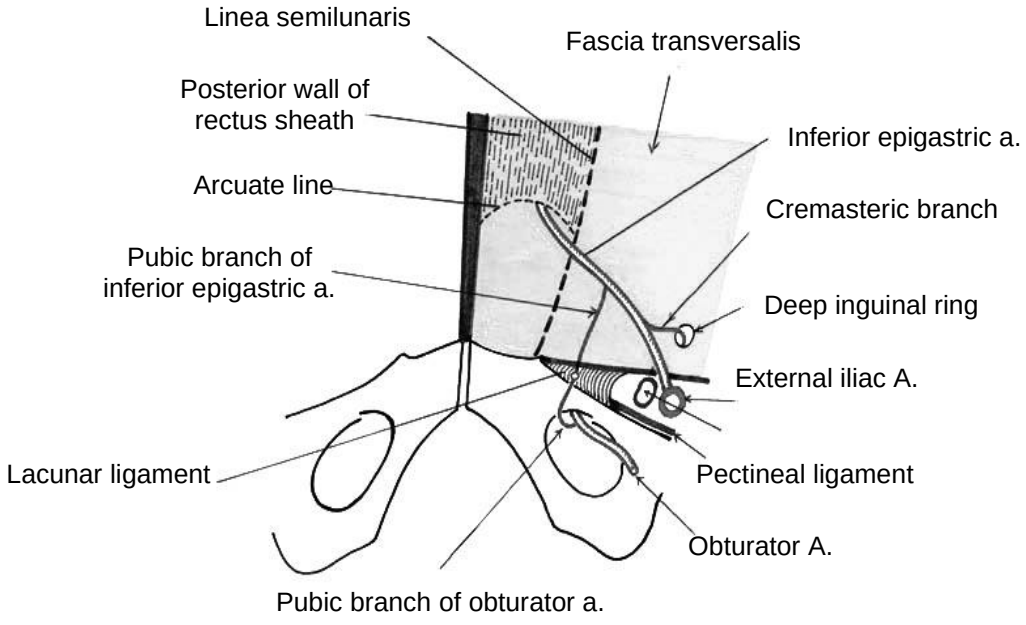



Superficial vessels
Deep vessels
Subclavian a. + v.
Internal thoracic a. + v.
Axillary v.
Lateral thoracic v.
Intercostal a. + v.
Musculophrenic a. + v.
Superior epigastric a. + v.
Thoracoepigastric v.
Subcostal a. + v.
Superficial inferior epigastric a. + v.
Inferior epigastric a. + v.
Deep circumflex iliac a. + v.
Superficial circumflex iliac a. + v.
External iliac a. + v.
Femoral a. + v.
External pudendal a. + v.
Great saphenous v.

* Arterial supply of anterior and lateral abdominal



Inferior epigastric A.



Anterior abdominal wall seen from inside the abdomen (from behind)

★ **Arterial anestomosis in the anterior abdominal wall:**

1) **Lateral anastomosis:** between the ascending branch of deep circumflex iliac, lumbar and musclophrenic arteries.
2) **Medial anastomosis:** between the superior and inferior epigastric arteries.

★ **Applied anatomy:**

- This anastomosis is very important to establish collateral circulation after obstruction of common or external iliac arteries.

Veins of Anterior Abdominal Wall

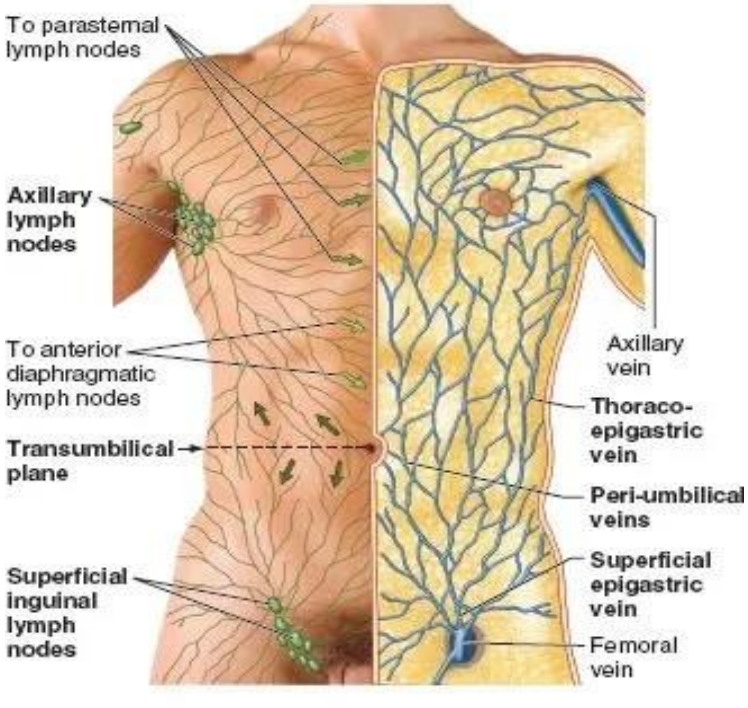
I) Superficial veins:

A) Above the level of the umbilicus:

- **Lateral thoracic vein:** runs in the superficial fascia on the lateral side of abdomen and thorax to end in the **axillary** vein.

B) Below the level of the umbilicus:

- **Superficial epigastric and superficial circumflex iliac veins:** run in the superficial fascia of the lower part of the abdomen to end in the **long saphenous** vein (tributaries of femoral vein)



Anterior view

II) Deep veins:

A) Above the level of the umbilicus:

- **Superior epigastric vein:** runs in the rectus sheath deep to the rectus muscle to end in the **internal thoracic** vein (a tributary of brachiocephalic vein).

B) Below the level of the umbilicus:

- **Inferior epigastric vein:** runs in the rectus sheath deep to the rectus muscle and ends in the **external iliac** vein.

C) Lateral veins : 4 lumbar veins drains into IVC.

★ Venous anastomoses in the anterior abdominal wall:

1. Anastomosis between **superior and inferior venae cavae**:

a) **Superficial lateral anastomosis** between the **lateral thoracic** vein and **superficial epigastric** veins.

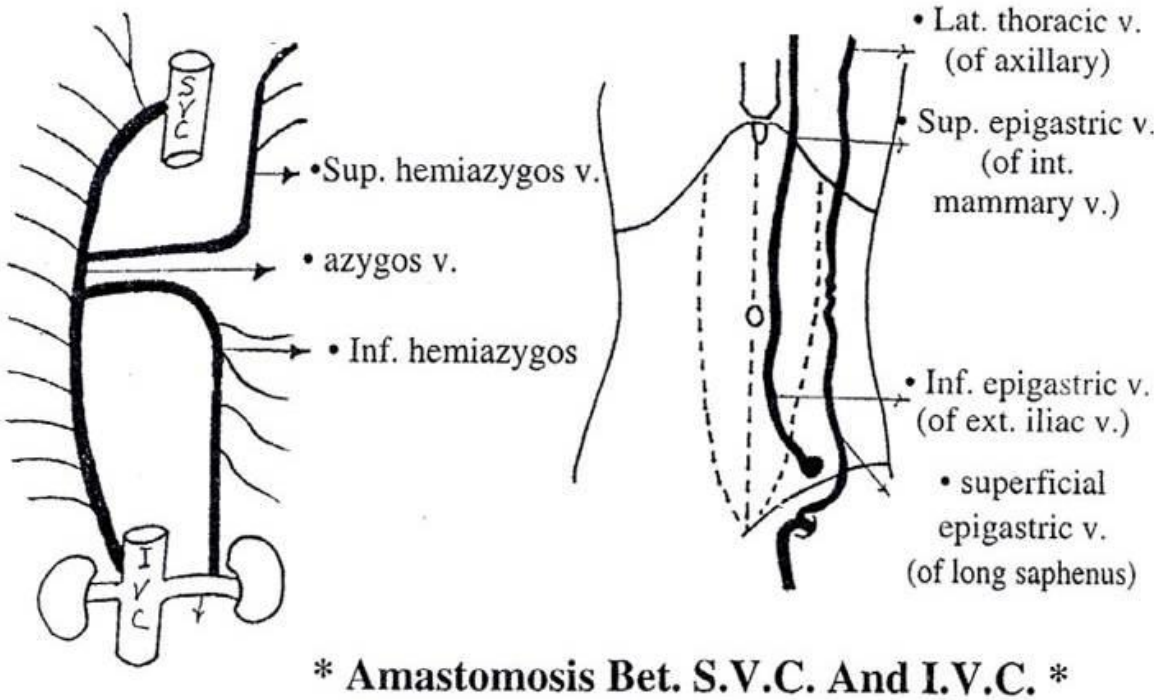
- This anastomosis forms the **thoraco-epigastric vein** which connects the superior and inferior venae cavae.

- **Applied anatomy**: **Obstruction** of inferior vena cava or iliofemoral veins, result in opening of this anastomosis with formation of **dilated veins crossing the groin**.

b) **Deep medial anastomosis** between the **superior and inferior epigastric** veins in the rectus sheath.

2. **Porto-systomic anastomosis** :

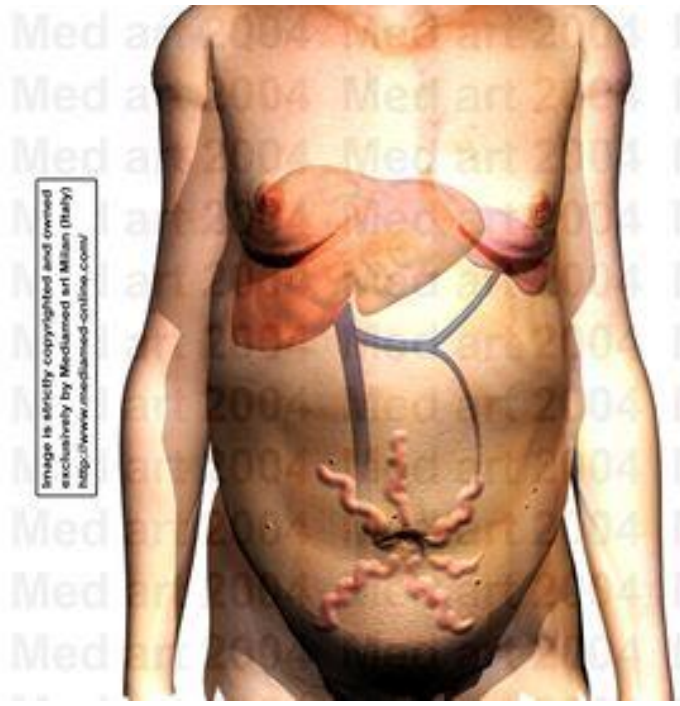
- Anastomosis between systemic veins of the anterior abdominal wall (tributaries of superior and inferior venae cavae) and persistent patent para-umbilical veins (tributaries of portal vein) in portal hypertension results in formation of **caput medusae**.



*** Amastomosis Bet. S.V.C. And I.V.C. ***

Patient with IVC Obstruction

Caput medusae



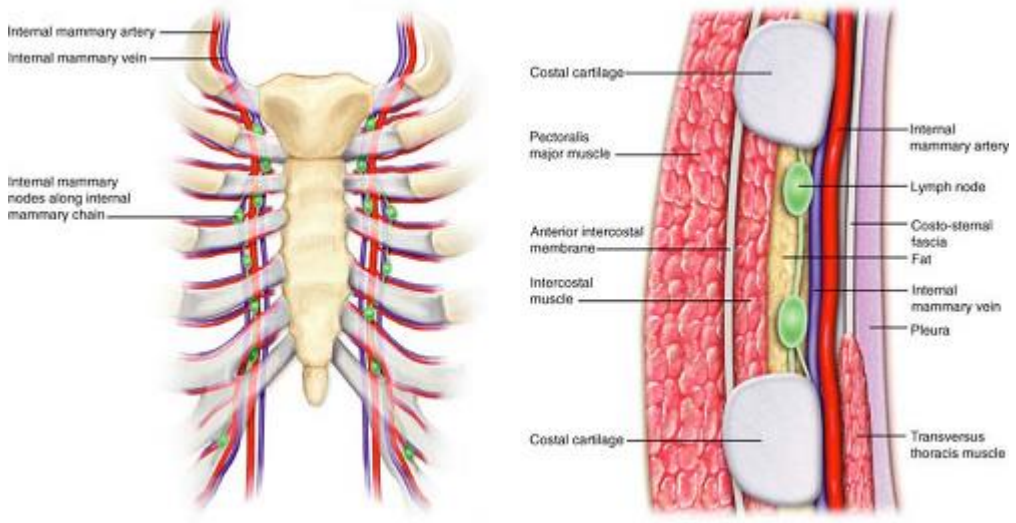
Lymphatic drainage of anterior abdominal wall

A) Superficial lymphatics: (follow veins)

1) ***Above the umbilicus:*** drain into the anterior (pectoral) group of axillary lymph nodes.
2) ***Below the umbilicus:*** drain into the superficial inguinal lymph nodes.

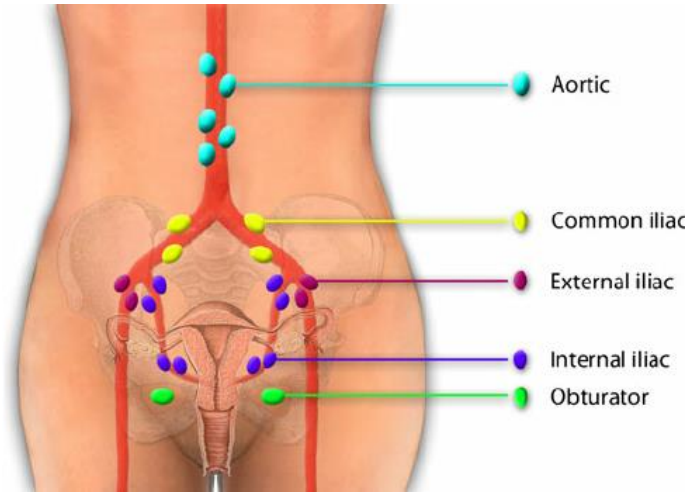
B) Deep lymphatics: (Follow arteries)

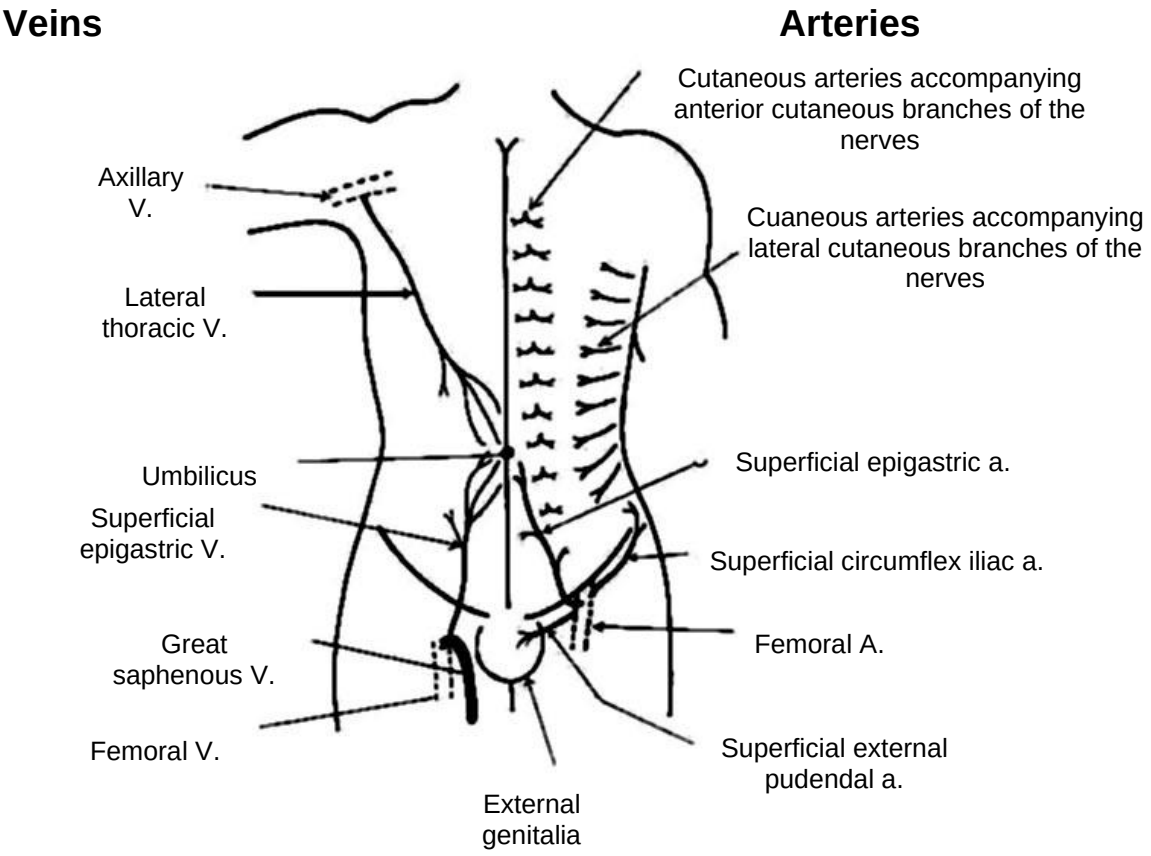
1) ***Above the umbilicus:*** drain into the **internal thoracic (parasternal**) lymph nodes (along internal thoracic artery).
2) ***Below the umbilicus***: drain into the **external iliac** lymph nodes.
3) The ***deep surface of the umbilicus*** is drained by lymphatics around the ligamentum teres, in the falciform ligament, which drain in the lymph nodes in the porta hepatis.



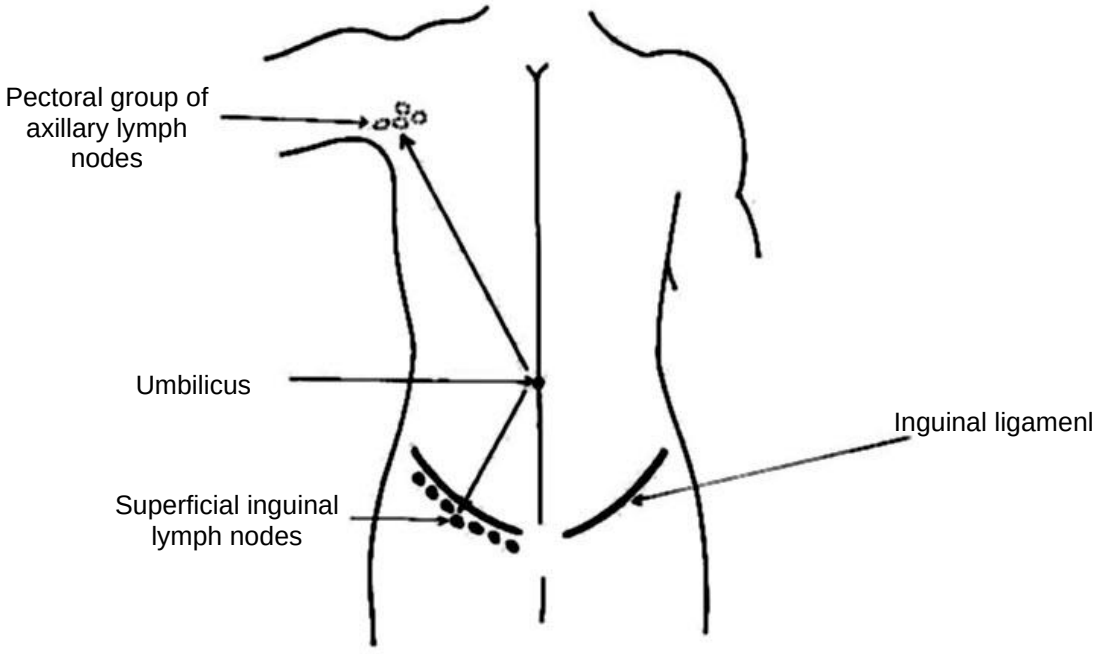
parasternal lymph nodes

External iliac lymph nodes





*** Cutaneous blood supply of anterior and lateral abdominal walls***



*** Cuaneous lymph drainage of anterior abdominal wall ***

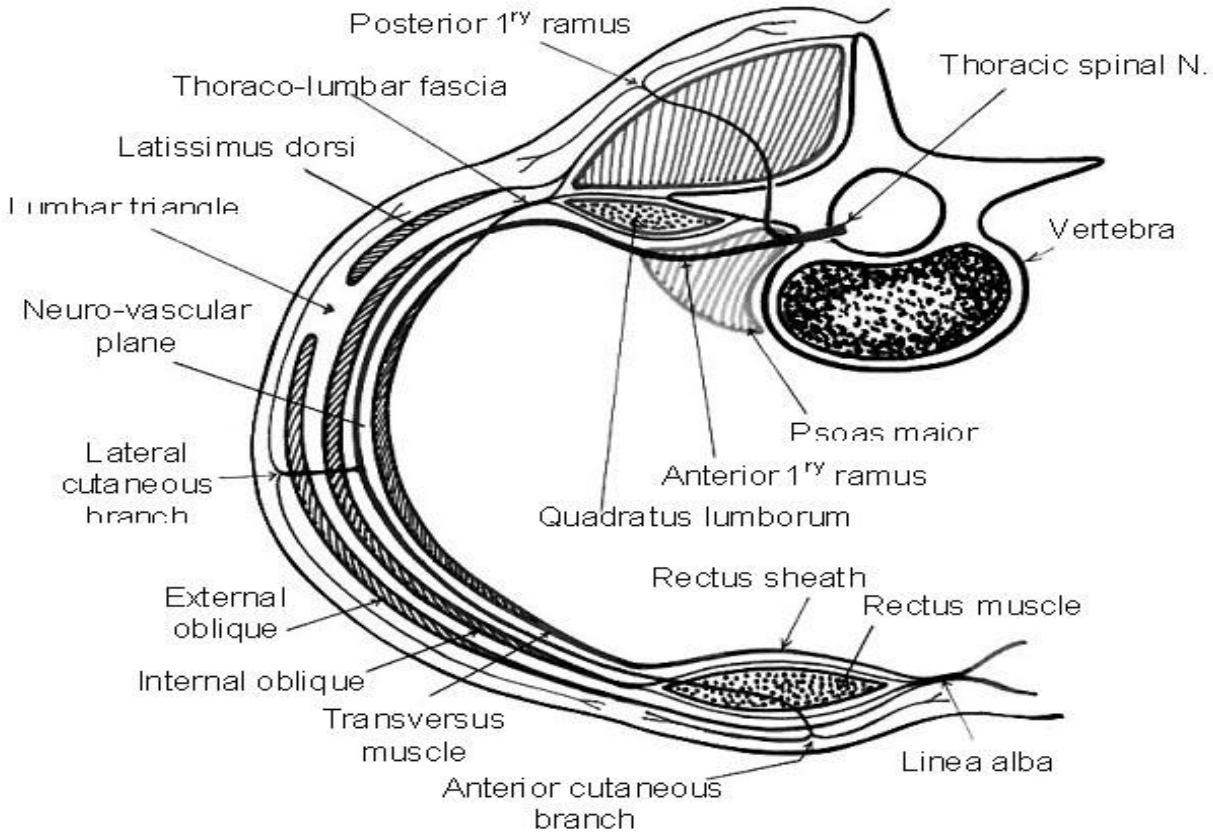
Nerves of anterior abdominal wall

A) Motor supply:

a) The lower five intercostal and subcostal nerves:

- They **supply** the muscles of the anterior abdominal wall.
- They pass through the **neuro-vascular** plane of the abdominal wall (between the internal oblique and the transversus abdominus), then enter the **rectus sheath** by piercing the posterior wall of rectus sheath close to linea semilunaris .

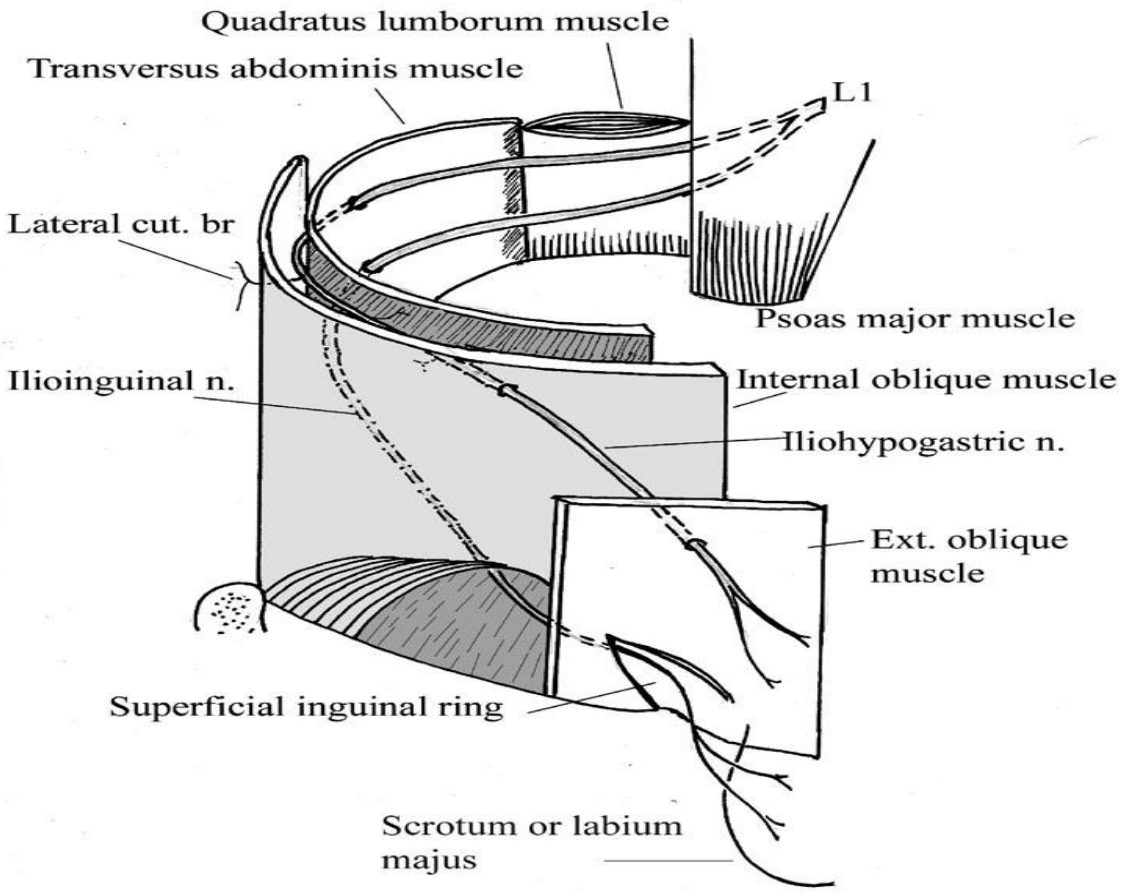
*** Subcostal nerve***
(Transverse section)



- They pierce the rectus abdominis after supplying it and pierce the anterior wall of rectus sheath to end by becoming the anterior cutaneous branch, lateral to the linea alba.

b) **Iliohypogastric and ilioinguinal nerves**: (branches of the anterior primary ramus of L_1).

- They **appears at the lateral border of psoas** major muscle ; then descend laterally , anterior to the **quadratus lumborum** muscle, with the iliohypogastric lying at a slightly higher level than the ilioinguinal nerve.
- **B**oth nerves **pierce** the transversus abdominis muscle and run forwards in the **neurovascular plane** between the internal oblique and the transversus muscles (supplying both) until they reach the level of anterior superior iliac spine; then they pierce the internal oblique at variable points and continue medially between it and the external oblique as cutaneous branch.



*** Iliohypogastric & ilioinguinal nerves ***

- The **iliohypogastric** nerve pierces the aponeurosis of the external oblique about 2 – 3 cm above the superficial inguinal ring.
- On the other hand, the **ilioinguinal nerve** pass in the inguinal canal first anterior then below the spermatic cord emerges through the superficial inguinal ring, to supply the skin of the scrotum (or labia major) and upper part of medial side of the thigh. It also supplies the **conjoint tendon**.

*** Applied anatomy:**

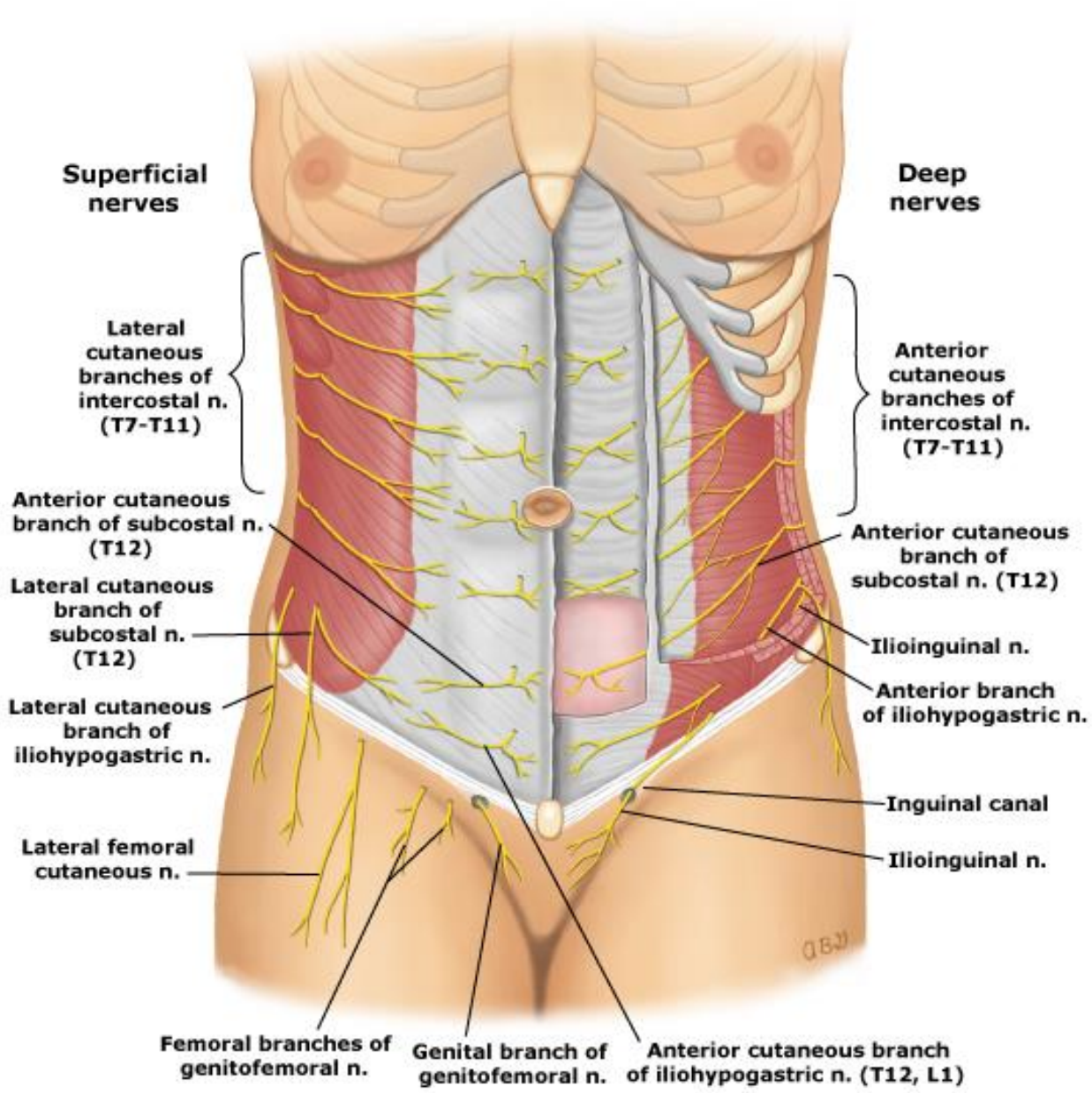
- Injury of ilioinguinal nerve , during appendicectomy , leading to paralysis of conjoint tendon which predispose to direct inguinal hernia.
- L_1 segment of spinal cord share in the nerve supply of the ureter .Therefore ureteric colic is referred to the scrotum and medial aspect of the thigh along ilioinguinal and femoral branch of genitofemoral nerve (L_1)

B) Sensory supply:

★ The lower five intercostal and subcostal nerves and the branches of L_1 supply successive and almost horizontal bands of the skin of the anterior abdominal wall as follows:

- Skin at the **subcostal angle** is supplied by T_7 .
- Three nerves ($T_{7, 8, 9}$) supply the region **above the umbilicus**.
- Skin at the level of the **umbilicus** is supplied by **T_{10}** (as that of the appendix).
- Three nerves ($T_{11, 12}$, L_1) supply the region below the umbilicus.
- Skin above the symphysis pubis is supplied by the iliohypogastric nerve (L_1).

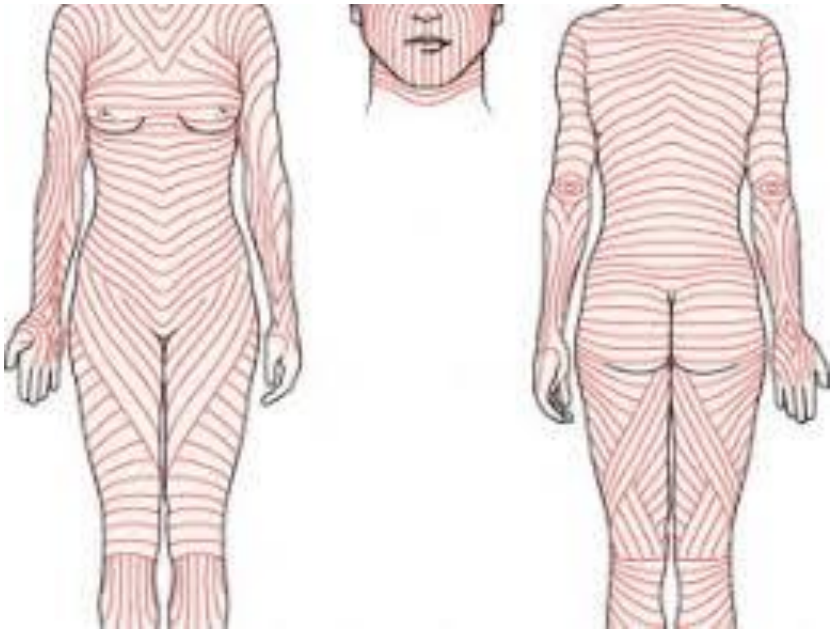
- Cutaneous branches of the **ilioinguinal** nerve. They supply the skin of the anterior aspect scrotum (or labia majora) and the upper part of medial side of the thigh.



Abdominal Incisions

★Requisites of good incision:

1. Maximum accessibility and adequate exposure.
2. Extensible.
3. Minimal damage to the muscles.
4. Avoid nerve or vessel injury to avoid paralysis or necrosis of muscles.
5. Minimal bleeding.
6. Rapid healing time.
7. **Minimal scar after healing** : When possible, the incision follow the cleavage lines (Langer's lines) in the skin which runs transversely in the abdomen. Incisions along (parallel) these lines heal with minimal scar but incisions across them heal by ugly scar.



Langer's lines

★TYPES OF ABDOMINAL INCISIONS:

I) Vertical incisions:

1. The midline incision (through the linea alba):

- According to **relation of the umbilicus ,** this incision may be upper or lower.
- **Advantages:**

a. It provides a bloodless field.

b. Could be extended above or below.

- **Disadvantages:** Prolonged healing time due to poor blood supply of the linea alba.

2. The paramedian incision:

- **Method:** This is done 2.5 – 4 cm lateral to the midline and parallel to it. The anterior rectus sheath is opened, the rectus muscle is retracted laterally and the posterior wall of rectus sheath together with fascia transversalis & the parietal peritoneum are opened in the same plane as the skin incision.

> ♣ **N.B: In general muscles & viscera are retracted toward their neurovascular supply .**

- **Advantages**:

a. It provides a bloodless field.

b. Can be extended.

c. Good healing in a short time as the rectus abdominis provides the incision with its arterial supply.

II) Transverse incisions:

- These are muscle cutting through the abdominal muscles as **Pfannestiel (bikini) incision which** is a transverse incision

made at the pubic hairline, for exposure of the female genital system (e.g. cesarean section) or urinary bladder .

- It may lead to some weakness of the abdominal muscles.

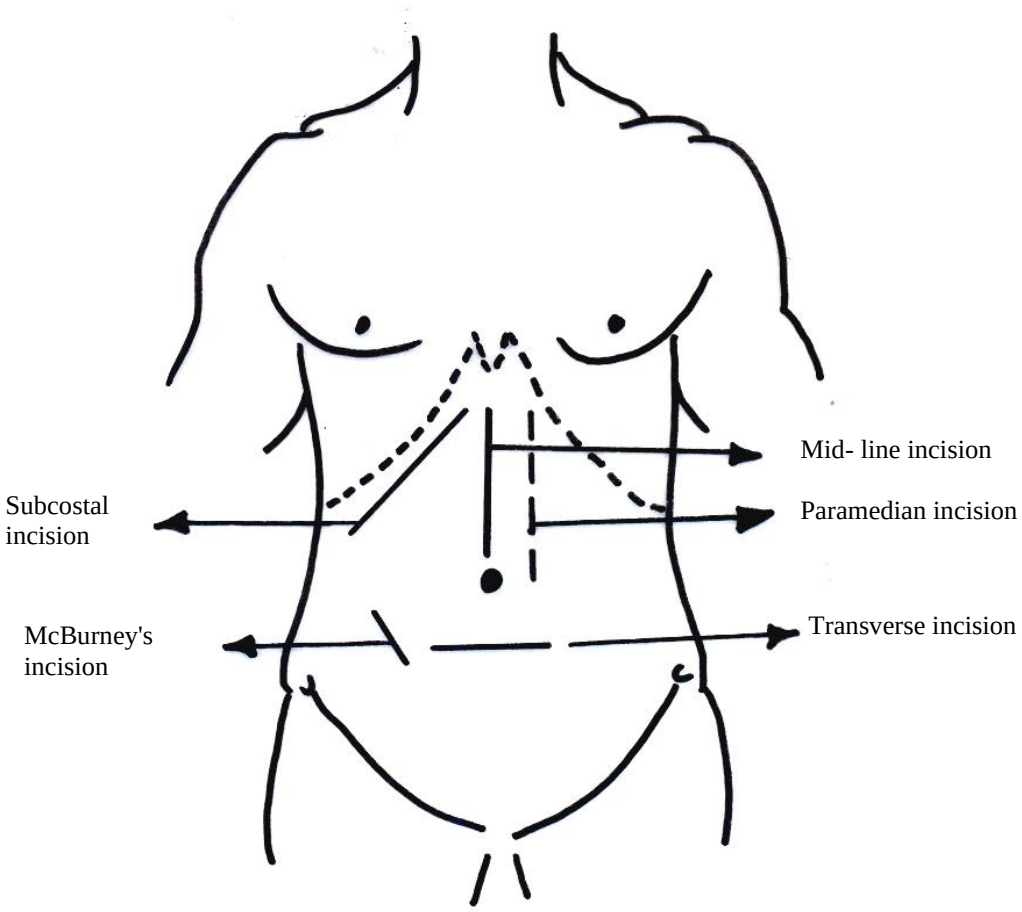
III) Oblique incisions :

1. Right or left subcostal incision:

- It is used to expose the gall bladder on the right side or the spleen on the left side.
- The skin incision begins in the middle line and extends one inch below and parallel to the costal margin.
- **Advantage:** good exposure.
- **Disadvantage:** a **muscle cutting** incision with high incidence of **incisional hernia**.

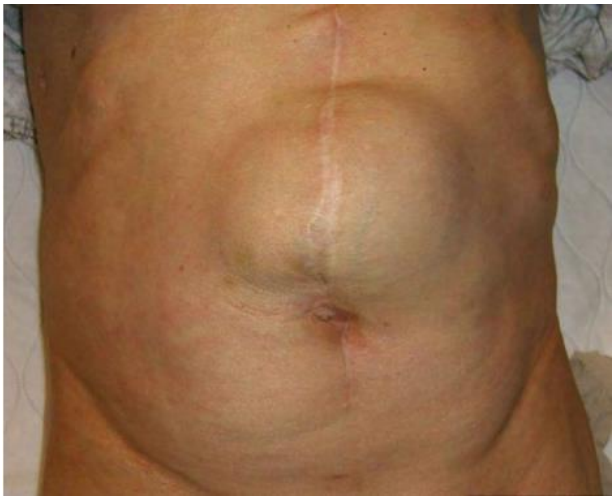
2. McBurney's incision :

- It is done to expose the vermiform appendix.
- **Method:** An oblique incision centered at Mc Burney's point (point at the junction of the lateral 1/3 and medial 2/3 of a line extends from the umbilicus to the anterior superior iliac spine).
  - ♦ Open the external oblique, internal oblique and the transversus abdominis (***without cutting them***) in the line of their fibers and retract them.
  - ♦ Finally open the fascia transversalis and parietal peritoneum.
- **Advantage:** a ***muscle splitting*** incision with no damage of the abdominal muscles.



* Applied anatomy :

1) **Incisional hernia :** It is a hernia occur in operative scar due to poor healing .



2) Minimal invasive , laparoscopic and endoscopic surgery :

- ♣ Recently the need for open surgery is markedly regressing and replaced by endoscopic surgery which is made through one of the natural body orifices or laparoscopic surgery through tiny perforations of the body wall .
- ♣ These new surgical procedures characterized by minimal post-operative pain , minimal hospitalization , rapid healing and no liability of incisional hernia .

❋ Applied anatomy of anterior abdominal wall :

1- **Liposuction :** is a surgical method for removing unwanted subcutaneous fat using percutaneous placed suction tube and high vacumm pressure .

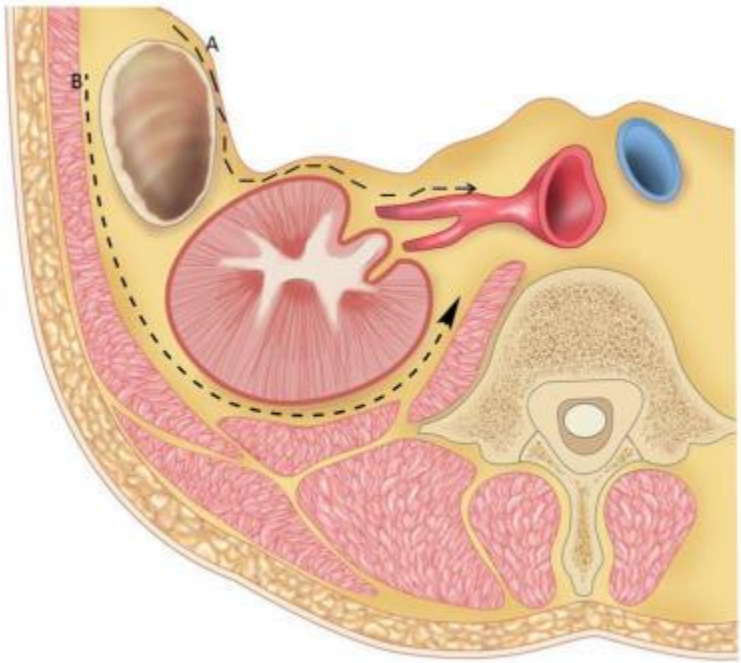


2- During **closure of skin incisions** below the level of the umbilicus , the **Scarpa's fascia** is included during the closure of the skin due to its strength .

3- Between the **Scarpa's fascia and the muscles** of abdominal wall , there is a **potential space** where fluid can accumulate e.g. urine in extra-pelvic rupture of urethra . Spread of fluid from this space to the thigh never occur due to attachment of Scarpa's fascia to the fascia lata along a line one inch below and parallel to the inguinal ligament .

4- **Extraperitoneal fat** between the endoabdominal fascia and the parietal peritoneum provide a plane which allows extra-peritoneal exposure of the structures on the posterior abdominal wall e.g. kidney and ureter to avoid peritoneal contamination during

operation . This plane is also used to place a mesh when repairing hernia.



5- **Protrusion of the anterior abdominal wall** is normal in **infants** and young children due to weak muscles , GIT contain excess air , relative small abdominal cavity and large liver .
6- **In adults abdominal protrusion** is due to food , fluid (ascites) , feces , flatus , fetus (6 F) , organomegaly (e.g. hepatosplenomegaly) , abdominal swelling (tumor) and muscle weakness (old age and insufficient exercise).
7- **In muscle weakness** , the muscles tone is insufficient to resist the increased weight of the protruded abdomen on the anterior part of the pelvis → anterior tilt of the pelvis (the pubis descend & sacrum ascend) → **excess lumbar lordosis** .
8- **Excess fat** accumulation in the abdomen is due to over nourishment and most commonly involving the subcutaneous fat , extraperitoneal fat and peritoneal folds .

9- **Warm hands** are important when palpating the abdominal wall because cold hand induce muscle spasm called guarding (protective mechanism).

10- **Irritation of parietal peritoneum** (e.g. peritonitis , appendicitis or cholecystitis) , induce involuntary reflex board like rigidity of muscles of abdominal wall .The common nerve supply of skin , muscles and parietal peritoneum of the anterior abdominal wall explain why these spams occur .

11- **Abdominal palpation** is performed with the patient in the supine position , the thigh and knees semi-flexed by a pillow under the knee and the arms at the sides to relax the anterolateral abdominal wall . If the thigh is extended, the fascia lata pulls the Scarp's fascia → tense abdominal wall .

12- **Superficial abdominal reflex** : With the patient supine and the abdominal muscles relaxed , gently and quickly stroke the skin from lateral to medial toward the umbilicus → contraction of abdominal muscles .This is a protective reflex so that injury of abdominal skin → contraction of abdominal muscles to protect abdominal viscera .