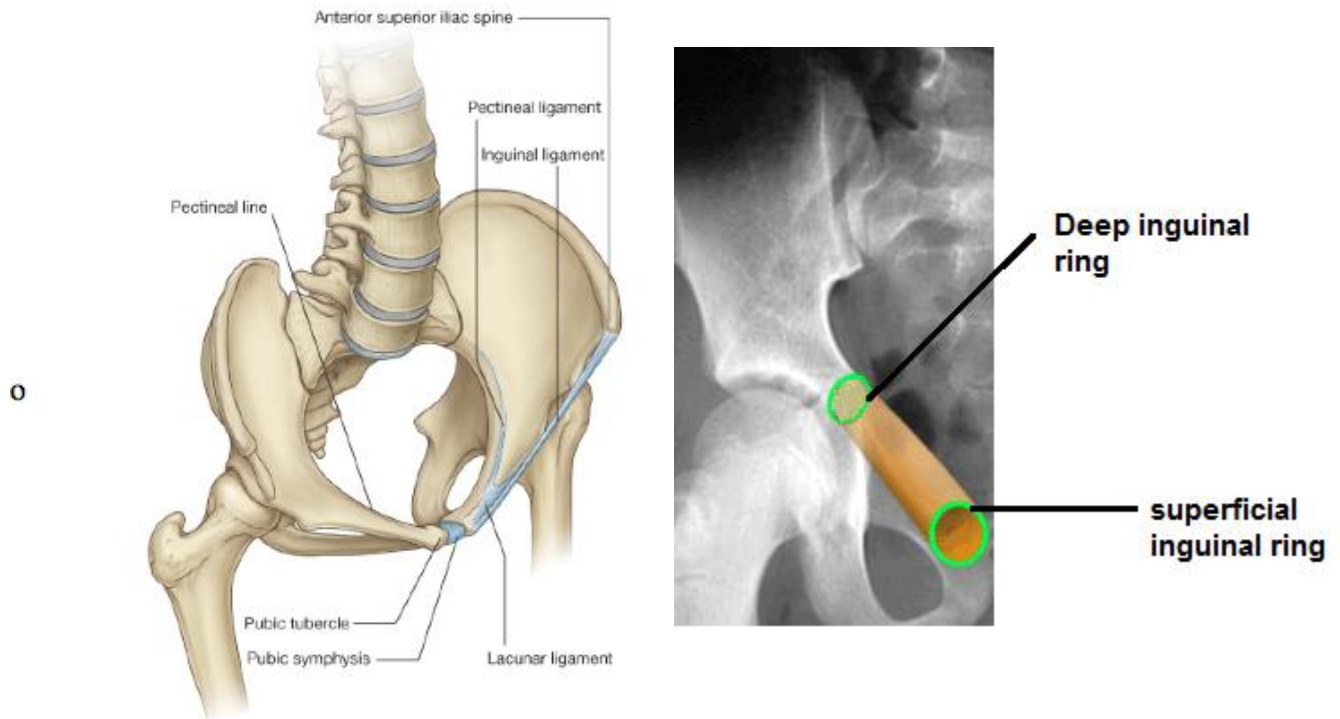


GI anatomy
sheet (4)

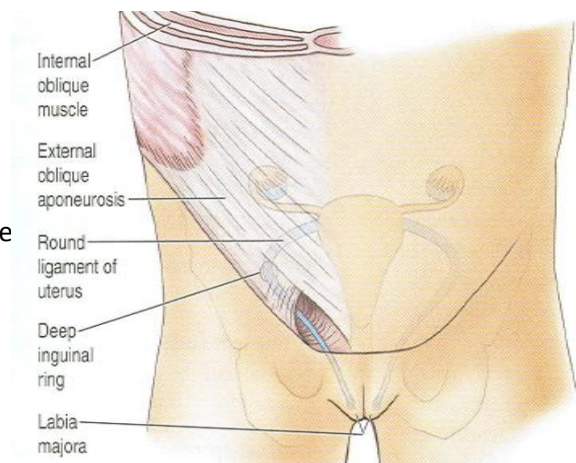
[This lecture is about the inguinal canal and inguinal hernia, this topic is important in surgery.]

The inguinal canal is a passage above the inguinal ligament. The inguinal ligament is a folding in the external oblique aponeurosis; it extends from the anterior superior iliac spine to the pubic tubercle.

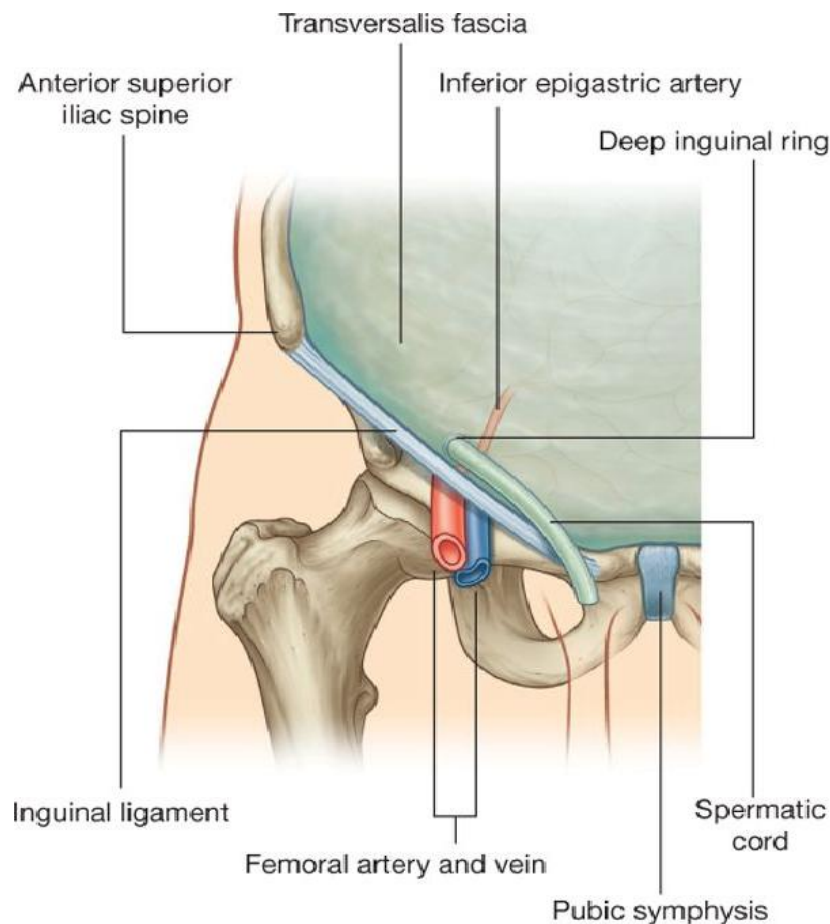


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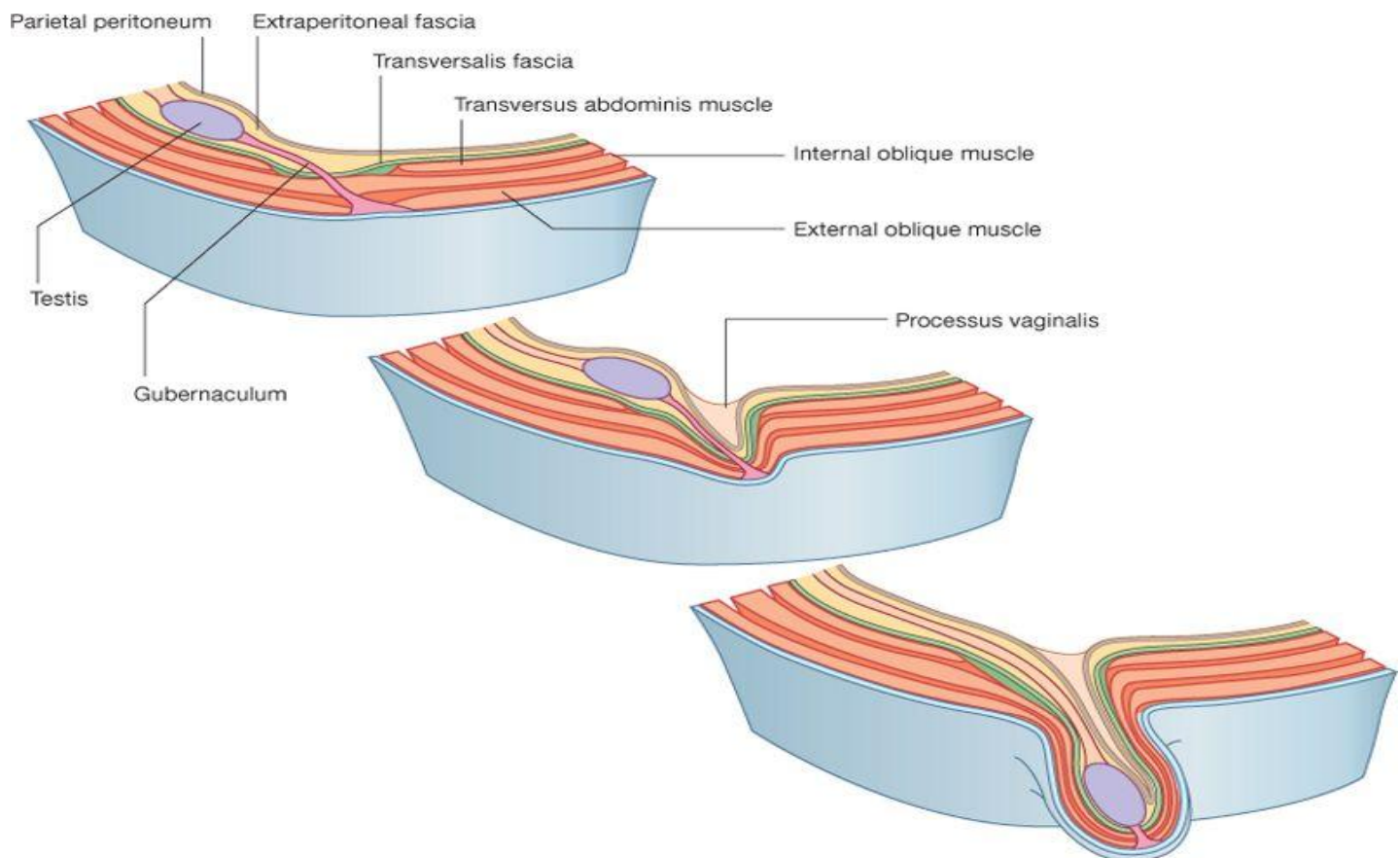
- The inguinal canal is a passageway that starts at the deep inguinal ring and ends at the superficial inguinal ring, it is **4 cm** in length, and It's a defect in the anterior abdominal wall.
- The inguinal canal is present in both sexes, the round ligament of the uterus passes through the inguinal canal to labia majora in females, while in males the spermatic cord passes through the inguinal canal to the testes in the scrotum.



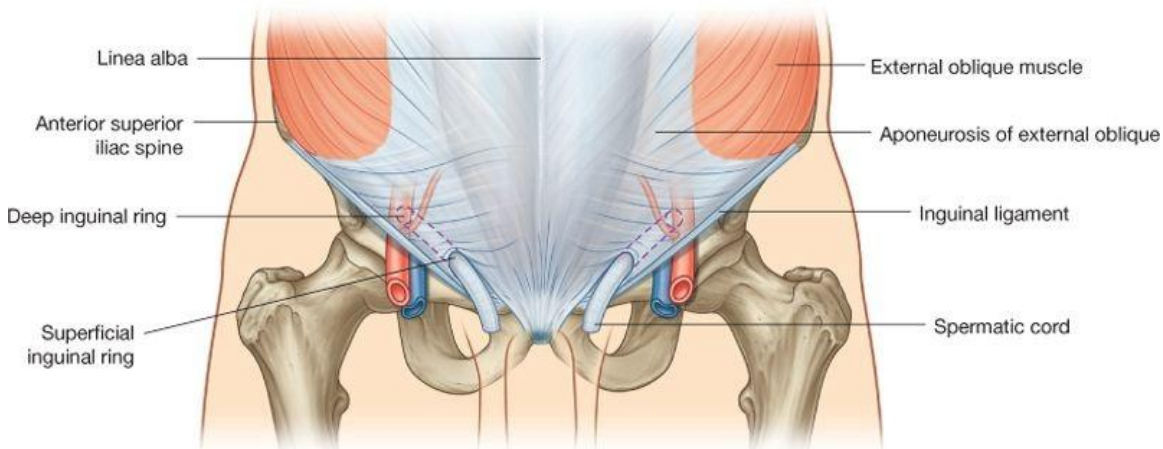
- The genital branch of genitofemoral nerve passes through the inguinal canal; the genitofemoral nerve comes from the abdomen then it passes deep to the inguinal ligament and it divides into femoral branch which provides a sensory cutaneous innervation to the skin of the upper medial side of the thigh, and a genital branch (motor) which passes through the inguinal canal and innervates the cremasteric muscle in the scrotum.
- The ilioinguinal nerve comes from the abdominal nerve L1, it enters the inguinal canal through its posterior wall (not through the deep inguinal ring) and passes through the superficial inguinal ring to the scrotum; it provides sensory innervation to the scrotum.
- The inguinal canal is 4 cm in length in adults, in newborns the deep inguinal ring lies opposite to the superficial inguinal ring, so in children it's short and straight, but in adults it's oblique.
- The deep inguinal ring is a defect in the transversalis fascia, which lies above the extraperitoneal fat and peritoneum.
- The deep inguinal ring is located 1 cm above the midinguinal point (midway between the anterior superior iliac spine and symphysis pubis)



- This defect in transversalis fascia occurs during embryogenesis; the testis are formed in the posterior abdominal wall at the level of L1, then they descend to the scrotum at the age of 8 months of pregnancy, they pass through the deep ring then the superficial to finally reach the scrotum. The testis are pulled to the scrotum with the help of something called **processus vaginalis** which is a part of the peritoneum and acts as a guideline to the testes to pull them from L1 level to the scrotum through the deep inguinal ring, and when the testes reach the scrotum the processus vaginalis is obliterated. And the deep ring is supposed to become completely closed but it remains a weak point. For example constant coughing and constipation increase the intra-abdominal pressure through contraction of abdominal muscles and that increases the pressure at this weak point and the contents of the abdomen might protrude to form an indirect inguinal hernia. So the deep inguinal ring is supposed to be completely sealed but for some reason (ex. Cough, constipation..) it might open to form an indirect inguinal hernia.

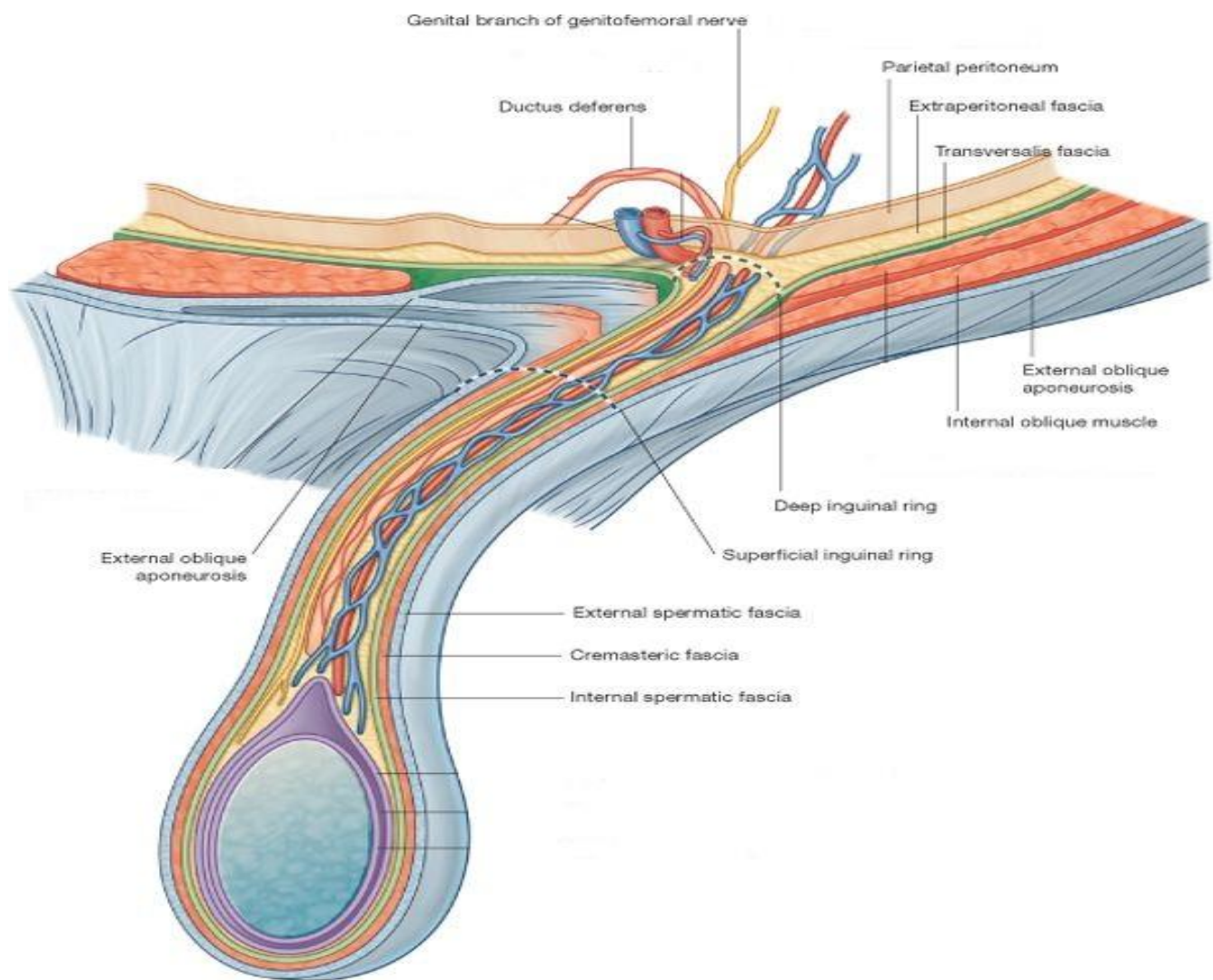


- The superficial inguinal ring is a defect in external oblique aponeurosis; it lies above and medial to the pubic tubercle.
- The femoral hernia which occurs at the femoral ring lies below and lateral to the pubic tubercle.
- The superficial inguinal ring is triangular in shape its base is formed by the pubic crest, the remaining margins are called crura (singular: crus); the lateral crus is attached to the pubic tubercle and the medial crus is attached to the symphysis pubis.



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- The spermatic cord is surrounded by three coverings which come from the inguinal canal, they're called spermatic fascia. They surround the spermatic cord all the way to the scrotum, these coverings are:
 - ** The first one is called the **external spermatic fascia**, it starts at the edges of the superficial inguinal ring and it's an extension of the *external oblique aponeurosis*.
 - **The second one is the **cremasteric fascia** with the associated cremasteric muscle, which is the middle fascial layer and arises from the *internal oblique muscle aponeurosis*; this fascia passes inside the inguinal canal.
 - **The third one is the **internal spermatic fascia**; this fascia is a continuation of the *transversalis fascia* at the deep inguinal ring.
- The spermatic fascia are found surrounding the round ligament of uterus but they're not well developed.



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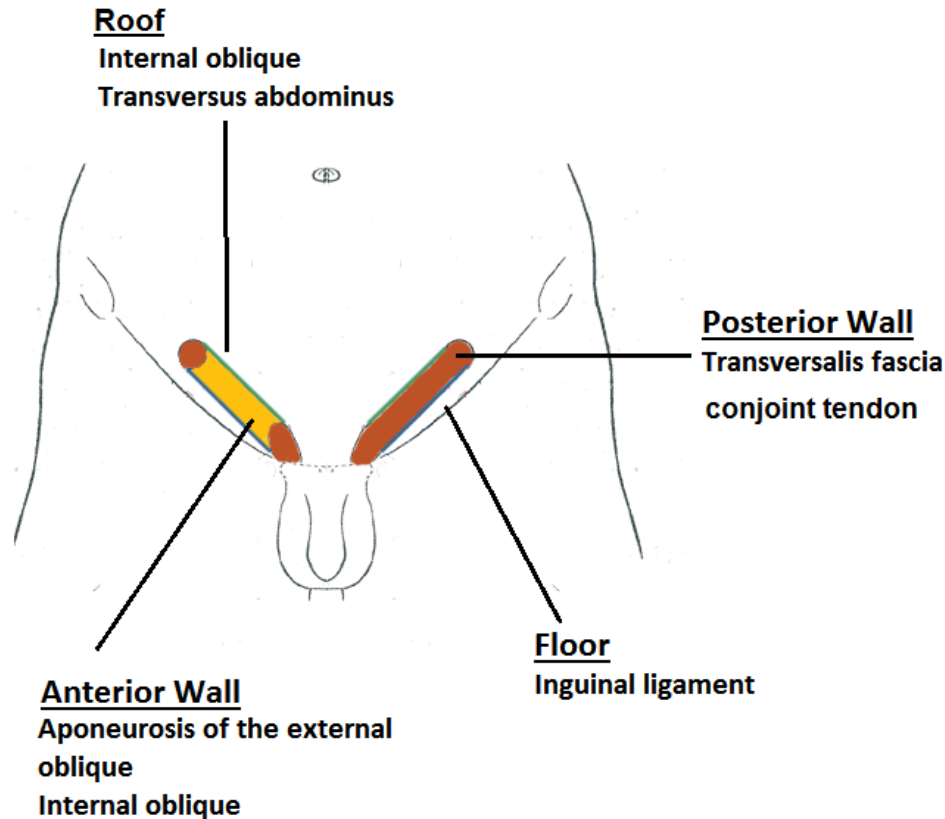
Boundaries of the inguinal canal

Floor: the inguinal ligament forms the floor of the inguinal canal.

Anterior wall: formed by the external oblique aponeurosis along its entire length, and opposite to the deep inguinal ring the anterior wall is reinforced and strengthened by fleshy fibers of the internal oblique muscle.

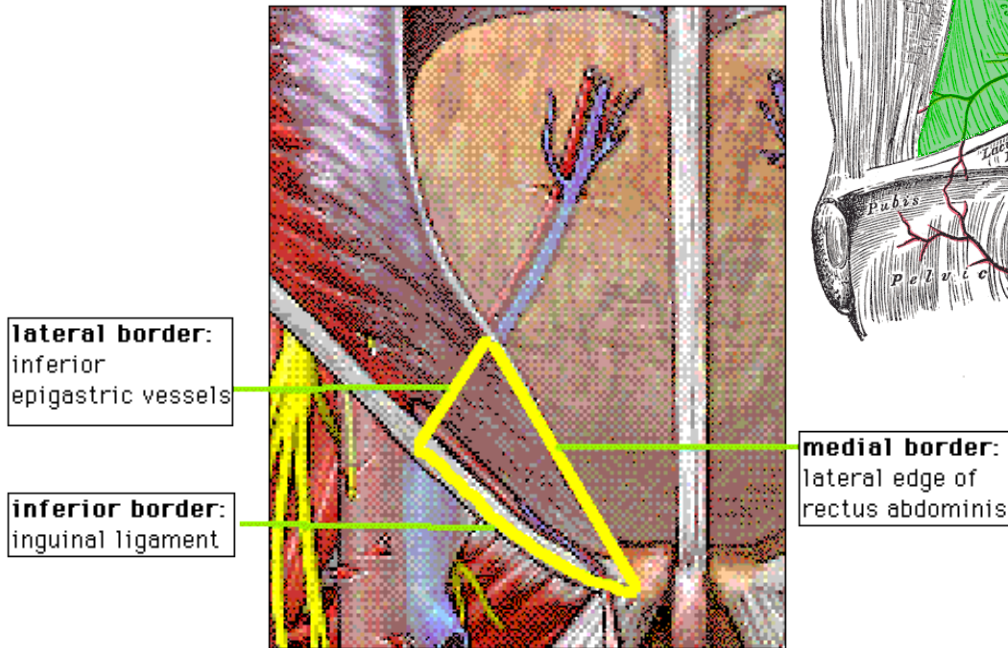
Posterior wall: the transversalis fascia, and reinforced opposite to the superficial inguinal ring by the conjoint tendon (internal oblique with transversus abdominis muscle and attaches to the pectineal line and body of pubis).

Roof: formed by arching fibers of internal oblique and transversus abdominis muscle.



- The type of hernia occurring at the inguinal canal is an indirect inguinal hernia.
- The most important function of the inguinal canal is the passage of the spermatic cord in males, and round ligament of uterus in females.
- Contents of the inguinal canal:
 - 1) the spermatic cord and its contents.
 - 2) Genital branch of genitofemoral nerve.
 - 3) Ilioinguinal nerve piercing the posterior wall and passing through the superficial ring.
- The spermatic cord, round ligament of uterus and genital branch of genitofemoral are the only structures that pass through the deep inguinal ring.

The inguinal triangle



- The inguinal triangle is a defect in the anterior abdominal wall, the word “defect” means that the location is a target for hernias.
- The type of hernia occurring at the inguinal triangle is a direct inguinal hernia.
- Boundaries of the inguinal triangle:
laterally: inferior epigastric vessels (vein and artery). The inferior epigastric artery is a branch from the external iliac artery, and its pulsation is felt.
Medially: lateral edge of rectus abdominis muscle, also called linea semilunaris.
Base: inguinal ligament.
- The anterior abdominal wall muscles are weakened with age (above 60 and 70), so with chronic cough and chronic constipation the contents of the abdomen protrude through the inguinal triangle to produce a direct inguinal hernia. Usually the protrusion is forwards in the anterior abdominal wall and it doesn’t reach the scrotum or the inguinal canal. And often the hernia is bilateral because it’s generalized weakness on both sides.

The spermatic cord

⇒ structures of the spermatic cord:

- 1) vas deferens.
- 2) Testicular artery and vein.
- 3) Testicular lymph vessels.
- 4) Autonomic nerves (especially sympathetic around the testicular artery).
- 5) Processus vaginalis.
- 6) Cremasteric artery.
- 7) Artery of the vas deferens.
- 8) genital branch of genitofemoral nerve.

- The spermatic cord starts at testis or tail of epididymis as vas deferens and enters the superficial inguinal ring then the deep inguinal ring; it enters the abdomen and reaches the posterior wall of the urinary bladder. The most important content of the spermatic cord is the **vas deferens**, also called ductus deferens, it's 45 cm in length, it transports the sperms from the tail of epididymis to the seminal vesicle which lies behind the urinary bladder.

The sperms are formed in the seminiferous tubules of the testis, then they aggregate in the epididymis to mature, then they travel from the tail of epididymis through the vas deferens inside the inguinal canal through the deep ring to the abdomen or pelvis to reach the seminal vesicle behind the urinary bladder, then there's the ejaculatory duct which opens into the prostatic urethra (note: the urethra is four parts; prostatic, penile, membranous and pre-prostatic) then the sperms are ejaculated.

- Another content of the spermatic cord is the **testicular artery and vein**; the testicular artery is a branch from the abdominal aorta at the level of (L2) opposite to the renal arteries. The testicular artery starts at the abdomen then reaches the deep inguinal ring and passes through the inguinal canal to the superficial inguinal ring to finally reach and supply the testes and epididymis.

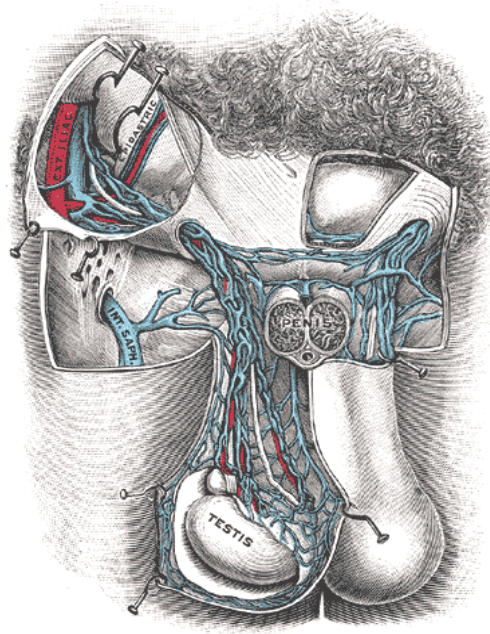
the testicular vein begins around the testis then the spermatic cord, at the beginning it's called **pampiniform plexus of veins**, then it enters the superficial inguinal ring and passes through the inguinal canal, and when it reaches the deep inguinal ring the pampiniform plexus becomes the **testicular vein** which enters the abdomen, it terminates by draining into the *vena cava on the right side*, while on the *left side* it terminates by draining into the *left renal vein*.

Thus a varicocele on the left testis is more common than the right, because the vein is perpendicular and longer because the left testis is at a lower level and is more dependent than the right and because the right testicular vein is oblique through its way

to the vena cava.

A varicocele is a cause of sterility in males, because varicoceles raise the temperature and kill sperms. A surgery is done and the pampiniform plexus is removed in such cases, and patients return back fertile and normal.

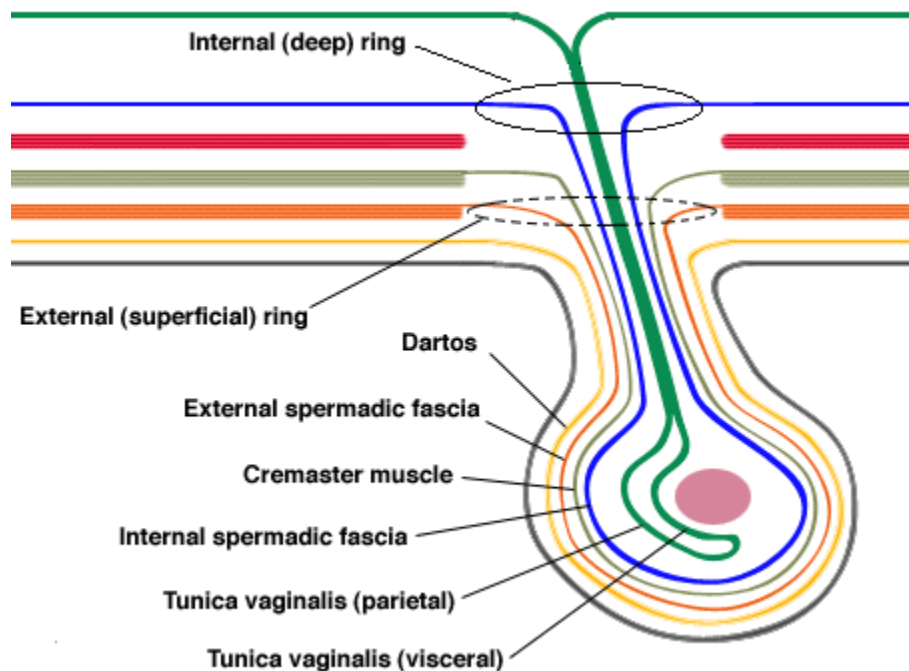
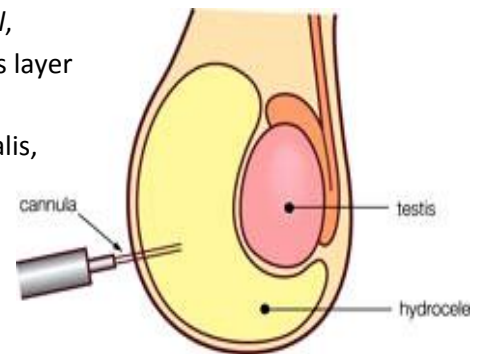
(Notice the pampiniform plexus and testicular vein at the deep ring)



- Processus vaginalis, which is a guideline to the testis, becomes the **tunica vaginalis** around the testes only, while the part that extends from the deep inguinal ring to the upper part of the testis is obliterated. If the processus vaginalis failed to obliterate it forms a congenital bilateral indirect inguinal hernia .
- The cremasteric artery is a branch from the inferior epigastric artery and goes to the cremasteric muscle.
- Artery of the vas deferens is a branch from the inferior epigastric and supplies the vas deferens.
- The genital branch of genitofemoral is motor to cremasteric muscle.
[The cremasteric reflex: irritation of the upper medial side of the thigh produces sensory impulses which travel through the femoral branch to L1, then signals from L1 to the genital branch stimulate the contraction of the cremasteric muscle to pull the testis upward.]

scrotum and coverings of the testis

- 1) Skin
- 2) Fatty layer which makes up the dartos fascia and dartos muscle
- 3) Membranous layer which forms colles fascia
- 4) external spermatic fascia
- 5) Cremasteric muscle and fascia
- 6) Internal spermatic fascia
- 7) Tunica vaginalis (remnant of the processus vaginalis around the testis), it's made up of two parts; *parietal* and *visceral*, it covers the testes from all side except posteriorly. In this layer a hydrocele might form, which is an accumulation of fluid around the testis between the two layers of tunica vaginalis, after a trauma to the testis. The fluid is extracted in a method called tapping which requires inserting a needle until reaching the **parietal part of tunica vaginalis** then aspiration of the fluid.



- The vas deferens is a cord like structure, it is 45 cm in length, it starts at the tail of the epididymis and ends at the seminal vesicle (correct the slides, the ejaculatory duct is what ends at the prostatic urethra).
- Autonomic nerves inside the spermatic cord:
 - **sympathetic (vasomotor) descend around the testicular artery.
 - **afferent sensory nerves from the testes and vas deferens.
- The testicular lymph vessels ascend from the testes and vas deferens upward to reach the Para-aortic lymph nodes on each side of the aorta at the level of L1. While the lymphatics from the scrotum drain into the superficial inguinal lymph nodes. Thus a tumor in the testis results in enlargement of para-aortic lymph nodes, while a tumor in the scrotum results in enlargement of the superficial inguinal lymph nodes.

The direct and indirect inguinal hernias

- A hernia is a protrusion of the contents of the abdomen through a weak point in the abdominal wall, whether anteriorly or posteriorly, as a result of increased intra-abdominal pressure due to chronic cough or chronic constipation. An example of a posterior protrusion is through the lumbar triangle, and that of an anterior protrusion is through the deep inguinal ring and inguinal triangle.
- The first layer to appear in a hernia is the parietal peritoneum , beneath it are the contents of a hernia which are usually the jejunum, ileum or greater omentum. Because these structures are long (6 m), have a mesentery and move inside the abdomen they are more likely to form the content of a hernia. A hernia is made up of a sac which covers the contents. At the deep inguinal ring there is the neck of a hernia.
- An indirect inguinal hernia is a common form of hernia (others are umbilical hernia, femoral hernia...), congenital in origin if the processus vaginalis failed to obliterate. Found lateral to inferior epigastric artery, adherent to the spermatic cord, sometimes the indirect inguinal hernia descends and reaches the scrotum and due to elasticity of the scrotum it will descend and enlarge.

The indirect inguinal hernia begins at the deep inguinal ring; it is 20 times more common in males. It descends forwards, medially and downwards, and its reduction (bringing it back to the abdomen) is upwards, laterally and backwards.

- The direct inguinal hernia occurs at the inguinal triangle, it is medial to the inferior epigastric vessels. It doesn't reach the scrotum because it's only bulging forward and is not related to the inguinal canal. Reduction of the direct inguinal hernia is backwards.
- A patient with a hernia is capable of reducing it back to his abdomen manually, but the problem with hernia is severe pain and the possibility of strangulation and cut of blood supply which leads to gangrene.
- A comparison between direct and indirect inguinal hernias:
 **first, two tests are performed, which are:
 1) we reduce the hernia till the superficial inguinal ring only, then we place the index above the superficial inguinal ring, if the pulse was felt laterally then it's direct hernia, if the pulse was at the tip of your index then its indirect inguinal hernia.
 2) The hernia is reduced till the deep inguinal ring, then you ask the patient to cough, if it was an indirect hernia it wouldn't form a bulge, if it was a direct inguinal hernia it would form a bulge because it's at the inguinal triangle.

	Direct	Indirect
Age	Common on old	young
Bilaterally	Usually bilateral	unilateral
Shape	Hemispherical	Oval
Reaches scrotum	never	Can reach the scrotum
Direction of descent	Forwards	Downwards , forwards medially
Reduction	backward	Upward, backward laterally
Relation to inf. epigastric art.	Medially	Laterally
Superficial inguinal ring test	Feel impulse on the side finger	Feel an impulse on the tip of the finger
Deep ring test Reduction of hernia, put thumb over deep ring, ask patient to cough	Hernia appears	Hernia does not appear
Coverings	1- Lat. To lat. Umbilical lig Same as indirection 2- Med. To lat	Skin, superficial fascia, Ex.sp.fascia, cremastirc muscle & fascia. Int spermatic fascia



This picture is of an indirect inguinal hernia, notice how the scrotum descends and enlarges, in a case the scrotum reached the level of the knees. And here the patient is capable of reducing the hernia with his own hands but it descends down again the moment he moves his hands.

