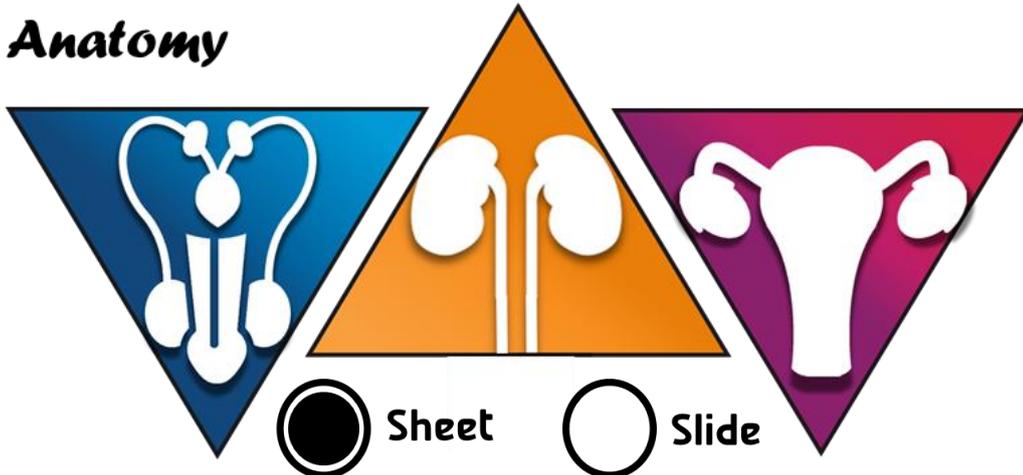




Urogenital system

Anatomy



Number:

- 13

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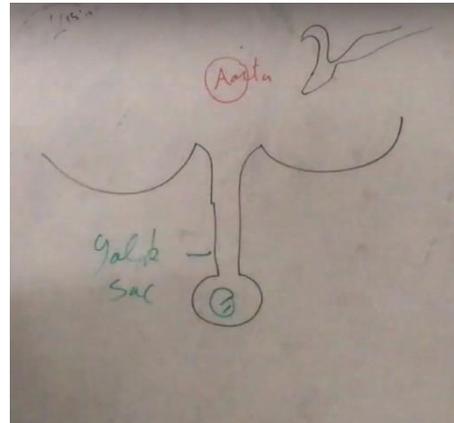
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Development of Genital System

The development of the genital system involves three parts: the gonads, tubes and external genitalia.

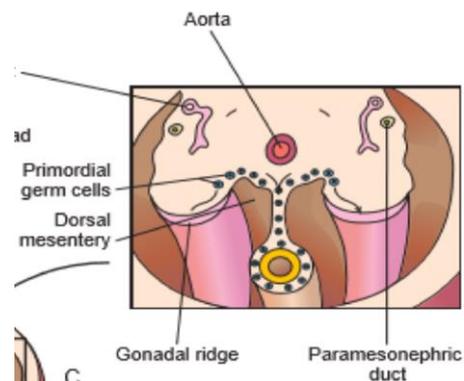
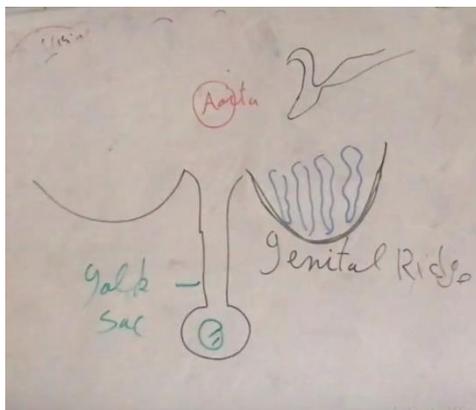
1- Development of the gonads.

Note on the following diagram these structures: we have the **yolk sac** in the middle, where development of ducts will occur. On either side of the yolk sac we have **coelomic epithelium**, surrounded dorsally by mesenchyme. Note also the dorsal aorta and near it the mesonephric duct (origin of the urinary system).



The coelomic epithelium will thicken to form **the genital ridge**. This ridge will further proliferate and invade the surrounding mesenchymal cells to form the **primary sex cords**.

At this stage (6th week of development), we have undifferentiated gonads i.e neither testes nor ovaries.



Development into testes

On the Y Chromosome of males, we have the **Testes Determining Factor** (T.D.F), and under its effect the undifferentiated gonads will develop into the male testes.

Under its effect, the primary sex cords will begin to elongate forming the **seminephrous tubules**. Ventrally, they'll lose their connection to the mesenchyme and start to form a fibrous capsule called **tunica albuginea**. Dorsally, the cords will join to form **Rete Testes** (which will then form the efferent ductules all the way to form the vas deferens).

The seminephrous tubules are lined by two types of cells: the supporting **Sertoli cells** and the **spermatogenic cells**. **Sertoli cells** originate from the mesenchyme surrounding the sex cords, meaning they are mesoderm in origin. While the **spermatogenic cells** will originate from migrating primordial germ cells from the yolk sac, making them endoderm in origin.

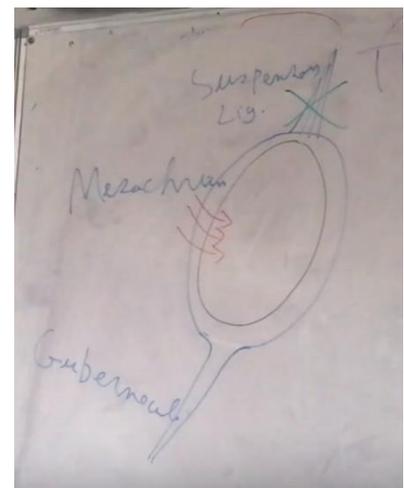
Another type of cells present in the testes is the **interstitial cells of Leydig**, which are responsible for the production of testosterone. The mesenchyme between the sex cords will give rise to those cells.

In conclusion, the testes are formed mainly from mesoderm with some endoderm from the yolk sac's germ cells.

Descent of the testes

The testes are developed at the level of L2 in the abdomen, where they also take their testicular artery. They will migrate from there until they reach their place in the scrotum.

As they descend, the testes are surrounded by **genital mesentery**. The cranial part of this mesentery forms the suspensory ligament of the testes which will degenerate later. The medial part of the mesentery will form the **mesorchium**, which lines the hilum of the testes where blood vessels and nerves enter. The distal part elongates to form the **gubernaculum**, which is a fibromuscular band that attaches to the lower pole of the testes until the scrotum underneath, it will pull the testes downwards.



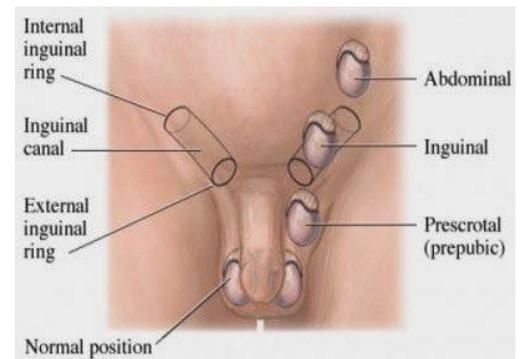
While descending, the testes will **invaginate** a fold of the peritoneum called **processus vaginalis**, which is composed of three parts:

- Proximal parts which obliterate forming **vestige of processus vaginalis**.

- Middle part which obliterates completely closing the connection between the abdomen and the testes, thus preventing hydrocele from occurring.
- Distal part which form **tunica vaginalis**.

Levels of descent:

- At 4-6 months, the testes reach the iliac fossa.
- At the 7th month they reach the deep inguinal ring.
- At the 8th month they reach the inguinal canal.
- At the 9th month they reach the superficial inguinal ring and the scrotum.



Congenital anomalies:

- 1- Undescended testes “Cryptorchidism”: the testes either remain in their place in the abdomen or anywhere along their pathway. That’s why it’s a routine thing to examine the new-born’s testes once they are born, this is to allow early treatment of this issue as it can be dangerous like causing infertility and carcinoma. (surgical descend and fixation)
- 2- Ectopic testes: descends but into an abnormal position: the thigh, lower abdomen, root of the penis etc.
- 3- Congenital hernia: the processus vaginalis remained unobliterated, in which loops of intestine descend via inguinal canal.
- 4- Hydrocele: the connection between the abdomen and the testes remained causing fluid from the abdomen to accumulate around tunica vaginalis of the testes.

The female genital system is formed by 2 stages as we will see:

The first stage: Development of the gonads

Same as in males, the coelomic epithelium, at each side of the yolk sac and the aorta, proliferates to form the germinal epithelium (genital ridge) which in turn forms the sex cords at each side. But for females, in the absence of

T.D.F, the undifferentiated gonad is switched on to form an ovary. The ovary is formed as below:

1- The invade into the subjacent mesenchyme to form the primary sex cords in the medullary groove, and these cords are called **medullary sex cords**.

From slides:” It replaced by fibromuscular stroma, forming the medulla of the ovary”

2- A second generation of sex cords are formed and called the **secondary (cortical) sex cords** which start to break down to form smaller structures which is called **perimordial follicles**.

3- Germ cells migrate and invade the perimordial follicles to form the **primary oocytes** which are arrested in the same stage until the puberty, and then they start to divide. It is all what the doctor said.

Important details from slides” Germ cells invade the primordial follicles and proliferate by mitosis to form Primary oocytes. At 12th week of the intrauterine life, the primary oocytes enter the first meiotic division and are arrested (at 20th week) in its prophase till puberty.”

4- The ovary developed (like the testis) in the posterior abdominal wall at the level of L2, where it is suspended by a genital mesentery. Then it starts to **descend and reaches the greater pelvis at 3rd month of gestation**, but it **reaches the lesser pelvis** (normal site) shortly at(in the slides it is after) **birth**.

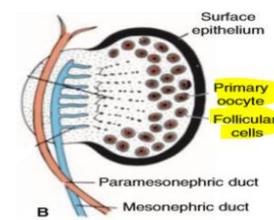
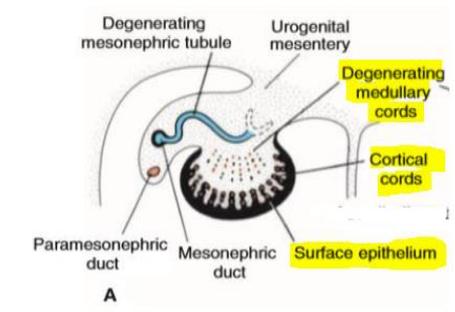
- What about the mesentery?

Same as in males, the **genital mesentery of the ovary** is divided into three parts:

a- **Cranial part** forms the **suspensory ligament of the ovary**

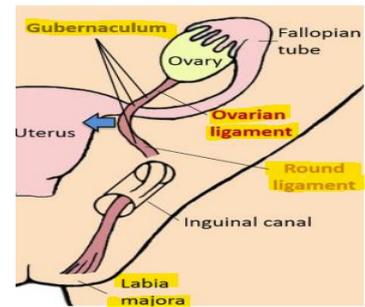
b- **Middle part** forms the **mesovarium**.

c- **Caudal part** is transformed into the **gubernaculum of the ovary**, which extends between the lower end of the ovary and the developing labium majora.



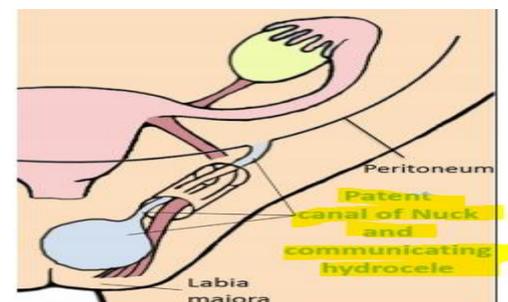
The gubernaculum pulls the ovaries inferiorly, and as it descends, it will be attached around the lateral angle of the developing uterus (uterotubal junction) and thus gives rise to two ligaments:

- 1- **Round Ligament of the ovary**, between the ovary and uterotubal junction
- 2- **Round ligament of the uterus**, between the uterotubal junction and labium majora



From the slides” As the middle parts of the paramesonephric ducts cross medially to reach the midline, they drag with them transverse folds of peritoneum, which will form the broad ligaments of the uterus”

- In the inguinal canal ,gubernaculum is located next to the canal of nuck (peritoneal pouch extend to labia majora) ,this canal must obliterate before birth , if remains patent it will result in hydrocele



The second stage: Development of the genital ducts

Up to the 6th week of development In either the male or female, there are two mesodermal genital ducts on each side:

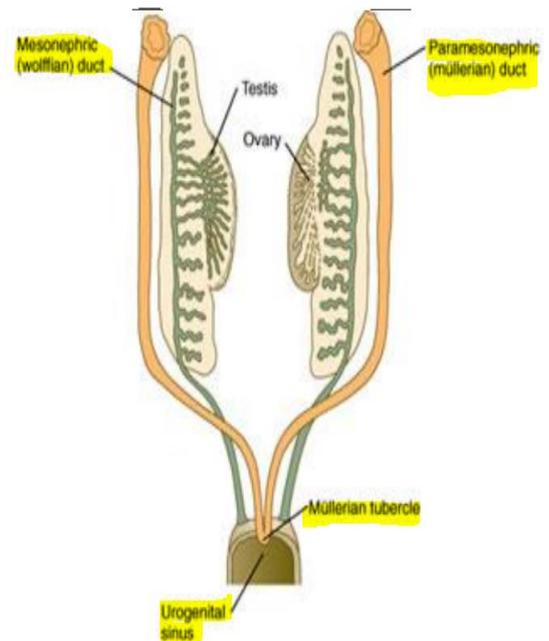
- 1- **Mesonephric (Wolffian)** duct which opens into the cloaca which is divided into anal and urogenital parts. It gives male structures mainly.
- 2- and a laterally located **paramesonephric (Mullerian)** duct . It gives mainly female structures.

- **In the male**, under the effect of **anti-mullerian factor (A.M.F)** synthesized by Sertoli cells of the testis, mesonephric ducts will develop, while the Paramesonephric ducts will regress, leaving vestigial structures.

- **In the female**, in the absence of A.M.F, paramesonephric ducts will develop, while the mesonephric ducts will regress leaving vestigial structures.

What happens?

- 1- The paramesonephric duct develops in the coelomic epithelium **lateral** to the cranial end of the mesonephric duct and continues to grow caudally lateral to that duct
- 2- Then **crosses ventral** to it and then **descends medial** to it.
- 3- Their lower parts fuse to form a **Y - shaped uterovaginal canal** project into **dorsal** wall of the urogenital sinus to form **Mullerian tubercle**.



Then:

- **Paramesonephric ducts in the male:**

As we said, they regress under the effect of M.I.F (Müllerian inhibitory factor) synthesized by Sertoli cells of the testis. But:

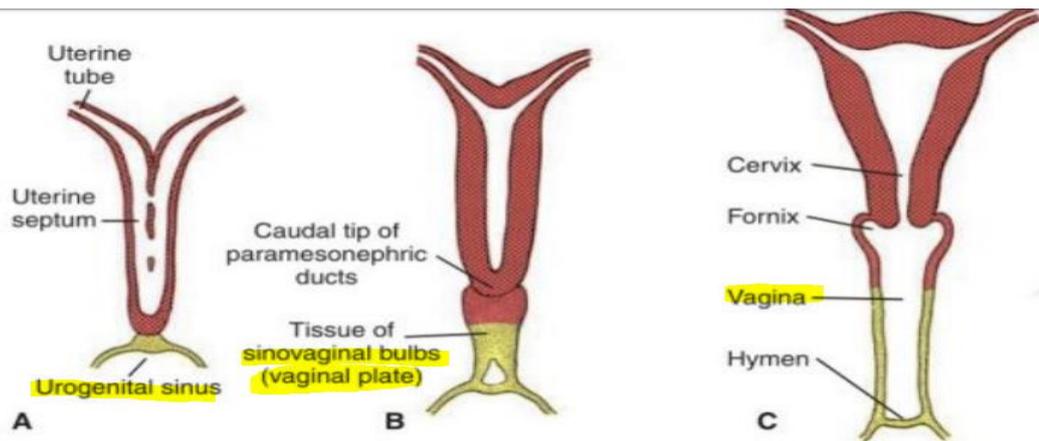
- 1- **Its cranial** end forms **appendix of the testis**.
- 2- **Their caudal** fused parts form **prostatic utricle**.
- 3- **Mullarien tubercle** gives rise to **seminal colliculus** in the posterior wall of the prostatic urethra

- **Paramesonephric ducts in the female:**

- 1- **The upper (cranial) 2/3rd** of each duct form the **uterine tube**, which opens in the coelomic cavity close to the ovary (notice that the upper end of each paramesonephric duct opens by an abdominal ostium into the coelomic cavity (future peritoneal cavity)
- 2- **Their caudal vertical 1/3rd (utrovaginal canal)** forms the **uterus and upper 1/3 of the vagina (mesodermal)**.

What about the lower 2/3rd s of the vagina?

They are formed from the dorsal wall of the urogenital sinus where ⁽¹⁾the Mullarien tubercle is located. ⁽²⁾Then the Mullarien tubercle will stimulate the urogenital sinus to form two solid invaginations called **sino-vaginal bulbs** which ⁽³⁾unite to form a **single vaginal plate**. ⁽⁴⁾The vaginal plate is canalized to form the **lower 2/3 of the vagina**.



So, the vagina is formed as follows:

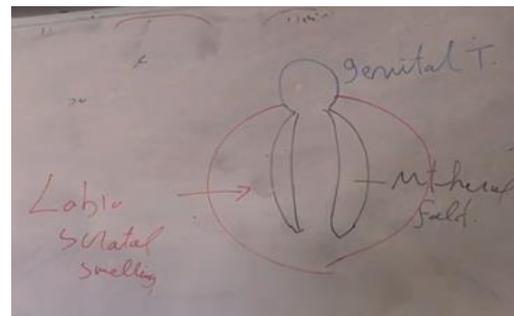
- 1- Upper 1/3 (**mesodermal**) develops from the lower part of the utrovaginal canal.
- 2- Lower 2/3 (**endodermal**) develops from the vaginal plate derived from the dorsal wall of the definitive urogenital sinus.
- 3- The last inch is (**ectodermal**) in origin

At the lower end of the vagina, a thin membrane remains to form the **hymen** that lies at the original site of the Mullerian tubercle, and this landmark is the border that separates between the mesodermal and endodermal parts of the vagina. (the lymph above this line ends into iliac lymph nodes, while below this line it ends into sup. inguinal lymph nodes.

External genitalia:

As we said previously that the cloaca has outer lining called cloacal membrane, this cloacal membrane is composed of 5 projections:

- Genital tubercle
- 2 Urethral fold
- 2 Labioscrotal swelling



In Males:

Genital tubercle:

genital tubercle will undergo elongation to form something called phallus (future penis).

*** Keep in mind that all structures here are **considered mesoderm**.

Penis contains **3** corpora (2 cavernosum and 1 spongiosum). Genital tubercle will form the 2 corpora cavernosum.

Urethral fold:

Remember that corpora spongiosum contains the penile urethra.

Urethral fold will undergo elongation, but it has unique way of elongation in which a groove will be formed between 2 urethral folds as you can see in the picture above, this groove will contain the **urethral plate** (endoderm in origin) which will undergo canalization to form the **urethra**.

Question: What is the difference between corpora spongiosum and urethra be mean of origin?

As we said above, the urethral fold will form the corpora spongiosum while the urethral plate will form penile urethra, the reason behind that is the embryological origin difference: Penile urethra is endodermal in origin (except the last inch which is ectodermal in origin) while corpora spongiosum which originates from the mesoderm.

So, Penis has 3 corpora (2 from the genital tubercle and one from urethral fold).

Labioscrotal swelling:

2 Labioscrotal swelling will undergo fusion in order to form the **scrotum**

Note: The above mentioned projections are found in both sexes (indifferent).

Quick summary:

In Males:

Genital tubercle will undergo elongation and gives rise to the phallus which will form 2 corpora cavernosum, urethral fold also will undergo elongation but there will be a middle groove forming the urethral plate which will be canalized to form the urethra (which is endodermal in origin except the last part that originates from the ectoderm)

Urethral fold will give corpora spongiosum, last thing is the labioscrotal swelling which will give the scrotum.

In Female:

Genital tubercle: will form the clitoris which is formed from 2 corpora cavernosum.

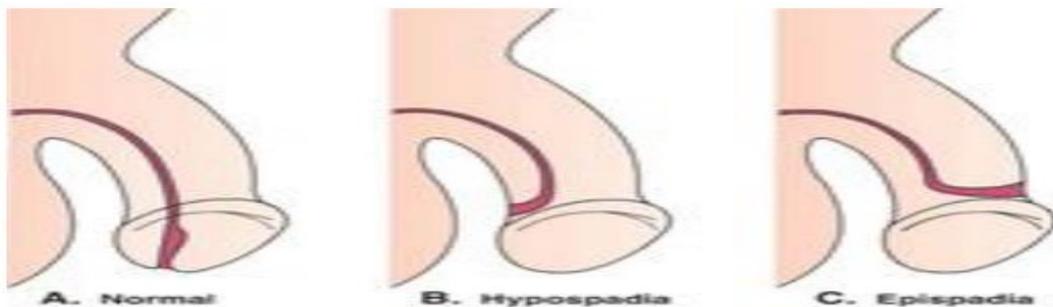
Urethral fold: will form the labia minora

The labioscrotal swelling will give rise to labia majora.

Congenital Anomalies:

epispadias: urethral opening is found in the upper surface(dorsal)
sometimes it's associated with ectopia vesica.

Hypospadias: urethral opening is found in the ventral surface, it could be midshaft, subcoronal or penscrotal.



Uterus didelphys with double vagina: Double uterus and double vagina.

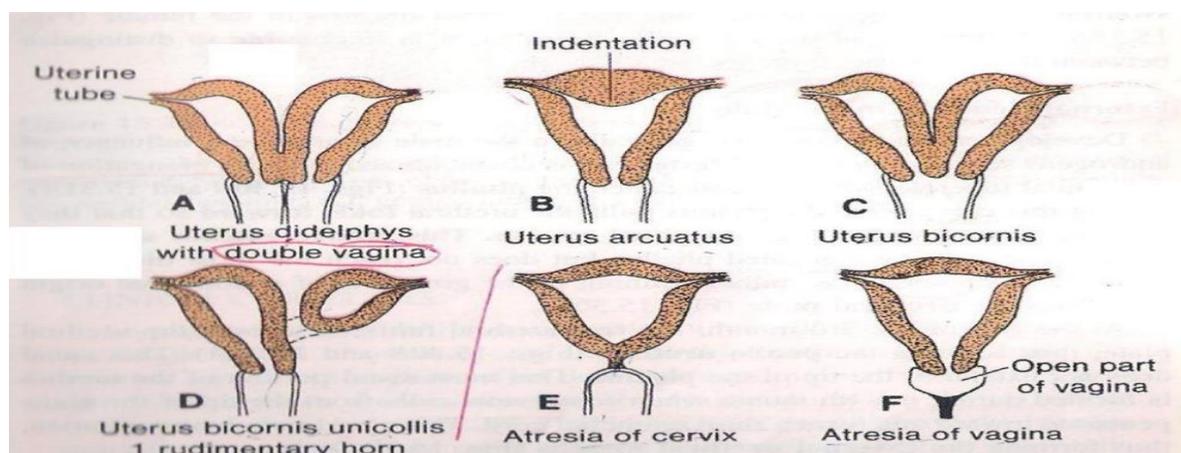
Uterus arcuatus: arcuate uterus; which means the fundus of the uterus will fall into the uterine cavity, this may lead to infertility.

Uterus bicornus: uterus with 2 horns.

Uterus bicornus unicollis: means that the uterus has 1 horn and the other horn isn't related to it.

Atresia of cervix: cervix is completely closed.

Atresia of vagina: Vagina is completely closed.



Very quick summary for all what was said previously in this sheet:

*In the case of testes: Coelomic epithelium will undergo thickening forming the genital ridge, yolk sac will give primordial germ cells, the primary sex cords will be formed, these cords will be elongated to form seminiferous tubules, primordial germ cells will go to seminiferous tubules (seminiferous tubules are composed of 2 things: germ cells “endoderm” and Sertoli cells “mesoderm”) then tunica albuginea will be formed in order to allow the testes to separate from the surrounding structures, but remember that it will be also grouped dorsally to form rete testis and epididymis ..

* Through the descend of the testes you can notice the gubernaculum that descend until reaching the scrotum, testes first will enter the deep ring then inguinal canal, then superficial ring to reach its final place which is the scrotum.

* Tunica Vaginalis is divided into 3 parts:

- 1) Proximal part is opened into the peritoneum, it will form the vestige.
- 2) Middle part will be obliterated.
- 3) Distal Part persists and forms tunica vaginalis.

*While in the case of ovaries: medullary sex cords will be formed then the cortical sex cords, cortical sex cords will form follicles, germ cells will migrate into the follicles in order to form primary oocyte.

*The descend of the ovaries:

Gubernaculum will be attached to the uterotubal junction forming round ligament of the ovary and round ligament of uterus, then descending to the inguinal canal and then it will attach to inferior surface of labia majora, Canal of nuck should be obliterated otherwise if it stays patent fluid will accumulate forming hydrocele which will lead to Labioscrotal swelling as you can see in the picture.

* Remember the mesonephric duct that opens into the cloaca (urogenital sinus part to be more specific), and also remember the paramesonephric ducts that will unite together forming uterovaginal canal, this canal will open into the urogenital sinus forming Mullerian tubercle.

* Talking about the genitalia, we said that there is genital tubercle, urethral fold and labiosrotal swelling, genital tubercle will undergo elongation to form the phallus that will form corpora cavernosum, and urethral fold will form corpora spongiosum.

End of sheet – Good luck ^^