

# ANATOMY

## SHEETS

*Collaboration with*



**Lecture: Oogenesis & Spermatogenesis**

**Doctor: Rashid AL-Jomard**

**Done by: Mohammad Alomari & رنيم العتوم**

**Edited by: Attaib Shqeerat & Mo'men**

**Shdifat**

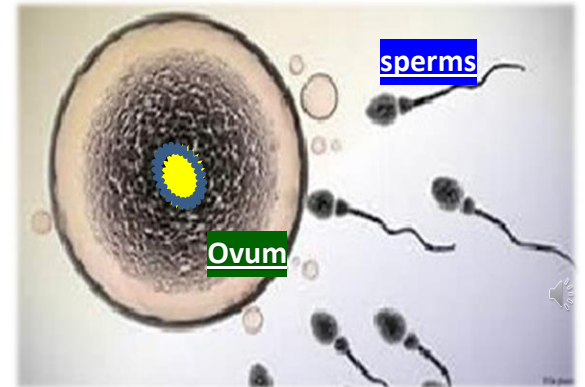
# Oogenesis

Welcome to the first part of 19th lecture in anatomy, we will proceed our journey in the reproductive system and go deep in Oogenesis. Let us go...

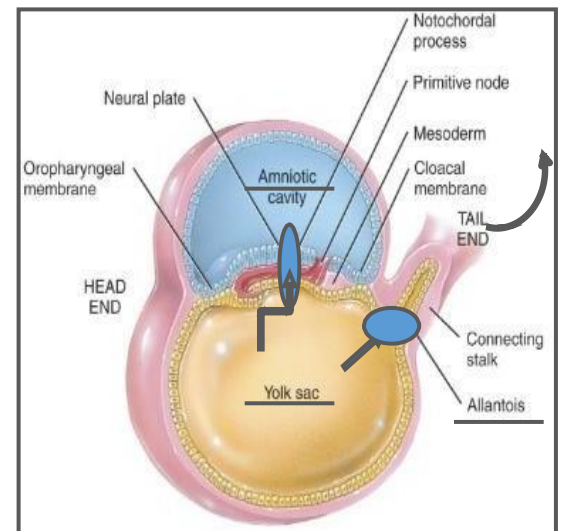


The international symbol of female

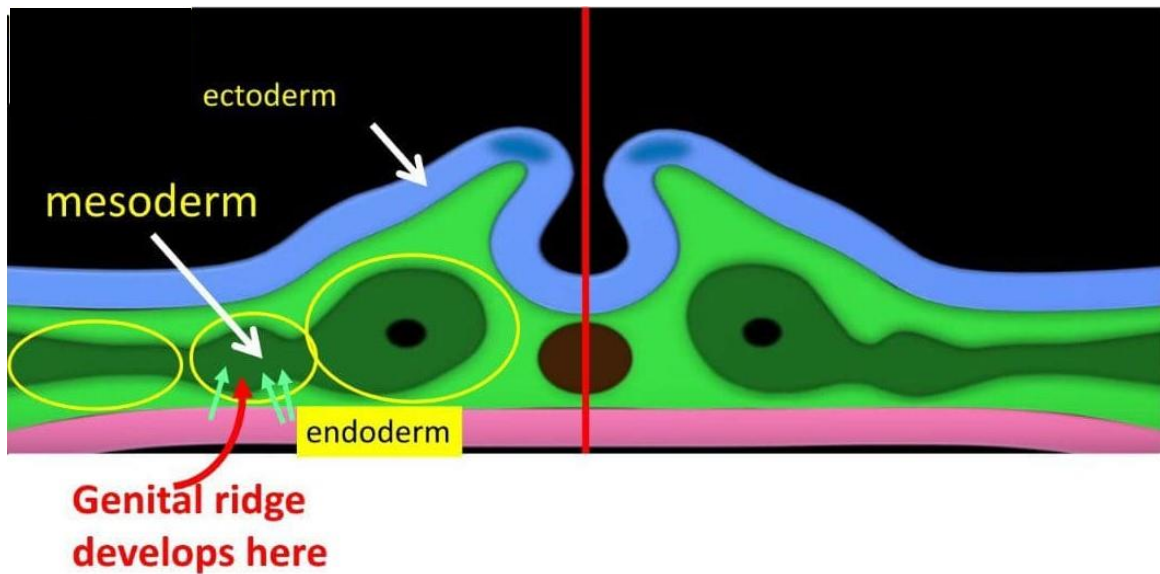
- Here is a view of nearly starting point ... We have two gametes, one is the female gamete and the other is male gamete they should come together, Once the nuclei of these two structure are meet and fused then we will start have a starting point of creating new live.
- This large cell it is the ovum (female gamete) and it is the single one. These sperms are trying to fertilize and join the nucleus of the ovum but **only one** will gong to succeed.
- Ovum and sperms need suitable environment to survive in gamete cell called sex cell.
- **Genital ridge**: where the gametes are developed and lived. **genital** mean reproductive system, **ridge** mean elevation .



- This structure is future human being, it is future embryo this is called **Embryonic Disc**, human body develops at it is first stage as a disc flat oval shaped disc. Above the embryonic disc we have **Amniotic cavity** this cavity filled with fluid for the sake of nourishment of embryonic disc.
- Under the embryonic disc there is a yellow sac called yolk sac which is a space filled with nutrient fluid for embryonic disc.



- Yolk sac has an extension into the umbilical cord is called allantois ,allantois projecting in this structure at detail in this is going to form the umbilical cord going from the umbilicus of the fetus later on to the placenta attachment to the mother uterus so that it gets nourishment later on.

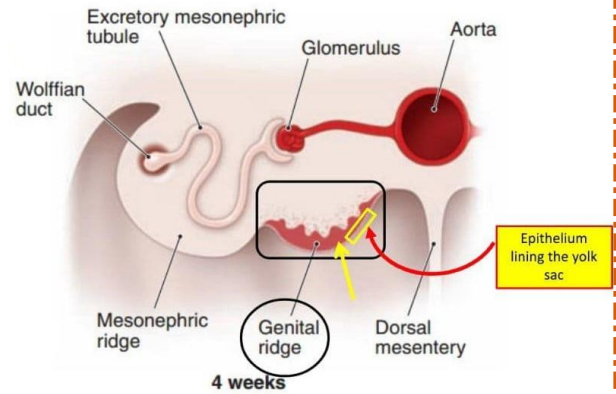


- The red line is midline between right and left half of the embryonic disc. At early stages human body is a disc an oval disc just like the paper .At later stage few days later the one paper disc like structure is going to be 3 paper one on top of each other .The top one (the blue) is the ectoderm the outer layer ,then the middle paper of the 3 (the green) is called mesoderm ,then we have lower paper of the 3(lower layer of the embryo ) is called Endoderm:
  - Your skin from ectoderm.
  - Your muscle and other structure under the skin they develop from mesoderm.
  - The lining of the stomach and intestine is develop from endoderm.
  
- The green layer(mesoderm) is going to segmented into 3 areas, this area inside this near oval shaped it near the midline is called the **paraxial** (axial mean midline ,paper mean around) then we have this segment between the 3 segment which called intermediate mesoderm and the one to your left it is the lateral segment of mesoderm.
  
- Intermediate mesoderm the place where gamete is housed very beginning of the primary sex organ call the **genital ridge** and this is place where it begins and then pink layer the endoderm it is going to send cells into this intermediate mesoderm.

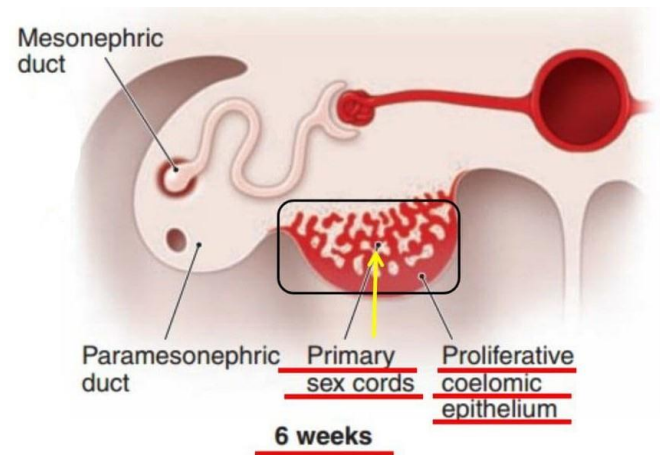


## ❖ The formation of genital ridge:

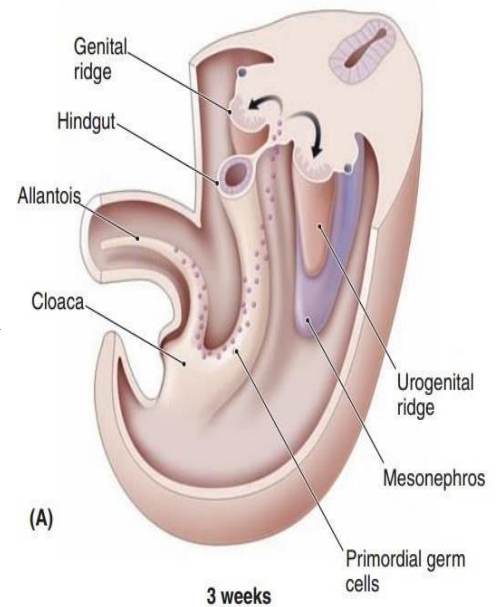
- Genital ridge the house where gamete going to be form.
- The structure inside the rectangle shape is Genital ridge. These arrow indicates that the cells endoderm are going to inflate the mesoderm and start collecting cells on the side of genital ridge these things happen in week 4 of the beginning of the fertilization.



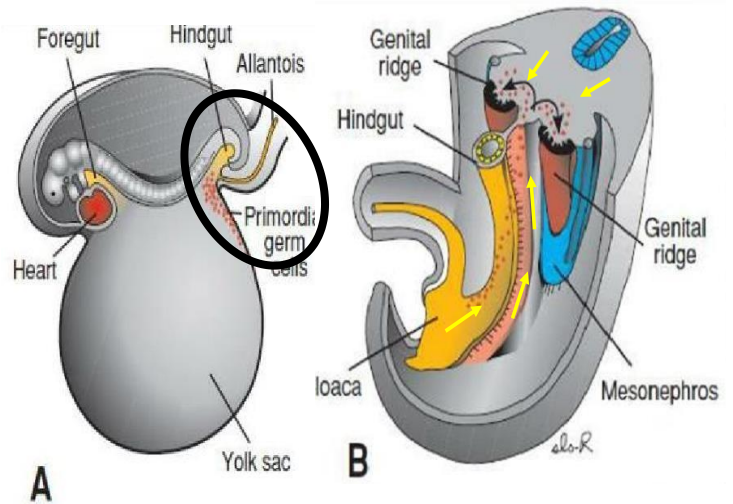
- In week 6 that is after 2 of the beginning of the invasion of the epithelial cell of the endoderm into the genital ridge they are going to divide and proliferate and there is origin from coelomic epithelium the epithelium lining the yolk sac. The arrangement of these cell they are in the form of cords (sex cord), called the primary because it is first to develop.



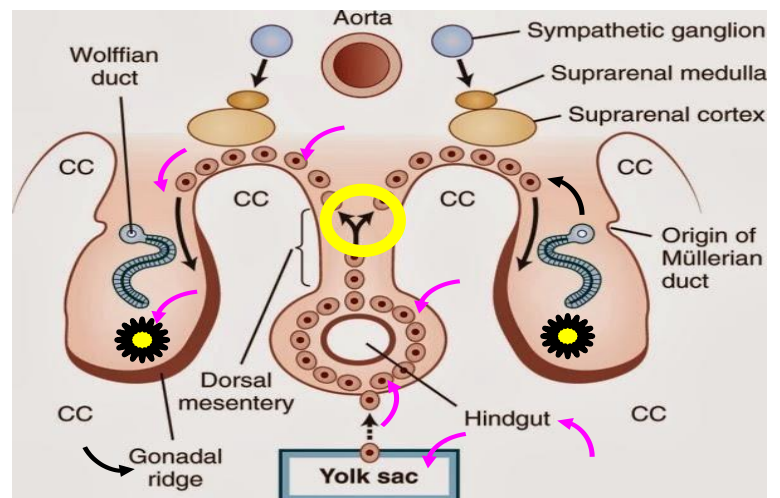
- Notice in this image the genital ridge on the right and the left the allantois is extension of the yolk sac umbilical cord and the very beginning of the sex cells the primordial germ cell they start to differentiate around the allantois and then they migrate these are the primordial germ cell . Look at the arrow they migrate along the nearest structure to them which is the large beginning of the large intestine once they reach the genital ridge it is go into the mesoderm of the embryo and start to settle down in the genital ridge between the primordial cords in both side.



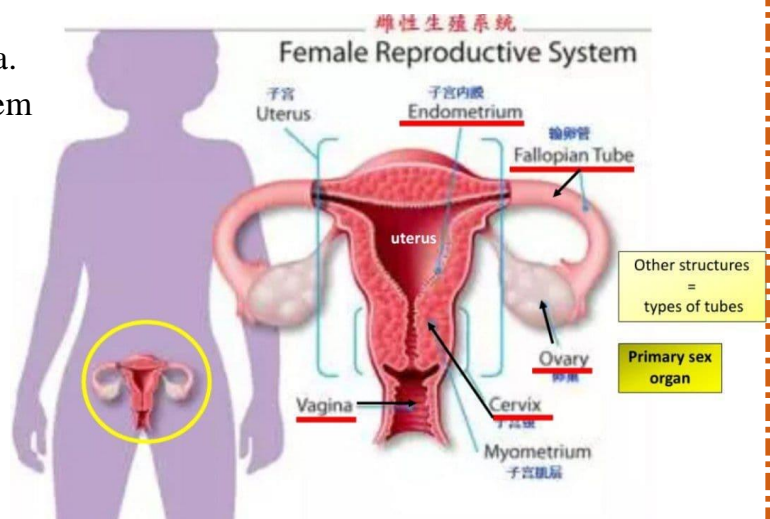
➤ A+B image repeating of previous page: in the circle this is the primordial germ cell and the yolk sac around the allantois and as they develop they migrate along the nearest structure which is the beginning of the large intestine the 3<sup>rd</sup> part of the intestine which called the **Hindgut** and they move and they enter the posterior abdominal wall made of mesoderm and Settle down in the genital ridge here is The yolk sac and the primordial germ Cell travel along hindgut the beginning of The large intestine and they move around and once they reach the midline some will go to the right and some will go to the left and settle down to the genital ridge or the gonadal ridge.



➤ developing of undifferentiated organ into ovary in female this change from undifferentiated into the primary sex cell which is the ovary is going to happen because of X chromosome in the pair of sex chromosome, gene and hormones .

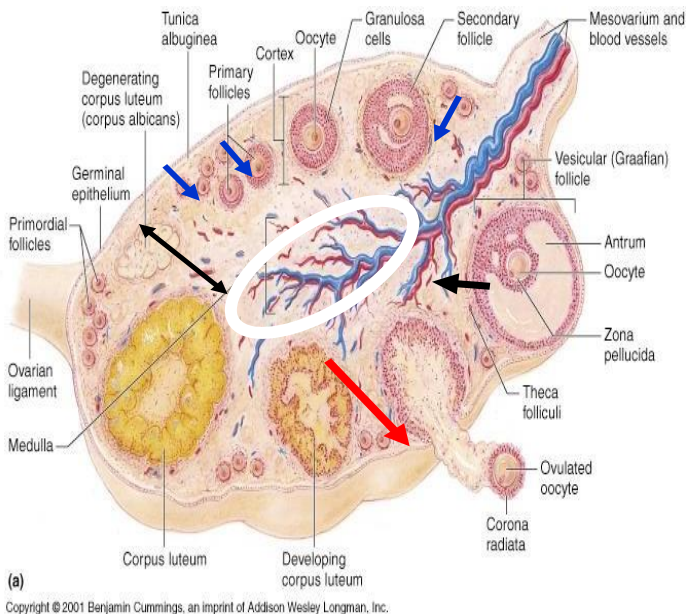


- the female genital system is in the pelvic and It is open to Outside through the vagina.
- The vagina fibro-muscular tube connect the cervix to outside
- The cervix is canal connect uterus and vagina.
- Uterus is central part of female genital system and it appeared shaped structure ,is the place for developing the embryo, it is there is a cavity lined with special cell called endometrium this layer receive and do the implantation of the embryo the wall of the uterus made of 3 layer the inside part is endometrium , the muscular part called the myometrium, the outer layer cover by serous membrane called peritoneum . the uterus open into 2 tube one on the right and one on the left and these called fallopian tube(uterine tube ) then we have the ovary is differentiated into the sex organ (primary sex organ).





- Why it is called primary? because it is a place for developing gamete (sex cell)
- The other type is tube for migration of gamete.



(a)  
Copyright © 2001 Benjamin Cummings, an imprint of Addison Wesley Longman, Inc.

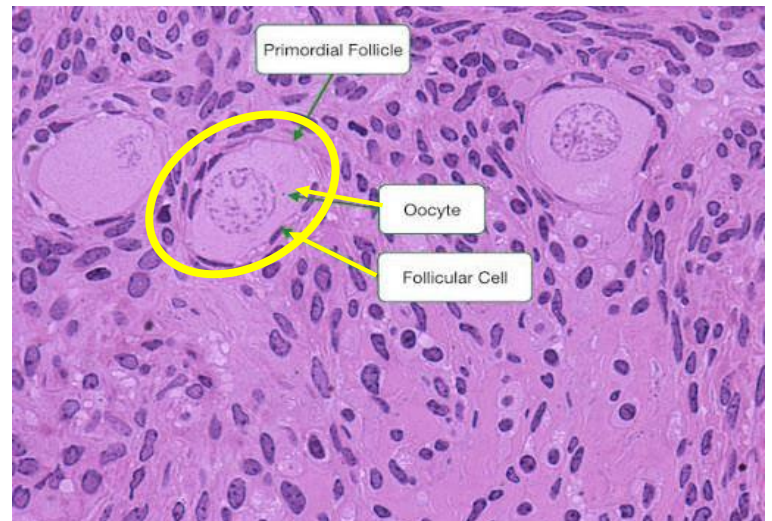
➤ **What is this figure?**

It is cross section of the ovary (female primary sex organ).

➤ The outer layer is the cortex in the cortex, we have the first or the primary Oogonium The 1st stage of starting to develop into Mature ovum, Then the oogonium is going to develop by adding more cell on the outside this called primordial follicle which is going to add more layer and then it called multilayer primary follicle and when surrounding cell start to develop its cavity it is going to be secondary follicle this cavity will unite with each other form large cavity once we have large cavity called Graafian follicle ,Graafian has large cavity the surrounding cells are the granulose cells are attach ovum to periphery cavity as it going to be larger and stretch the outer surface of the ovary and then it ruptures ,the follicle rupture oocyte release from the ovary.

➤ **Inside yellow oval shaped there are 2 thing:**

1. Big cells surrounded by cells called the primordial follicle least develop follicle in the ovary.
2. The large cell inside primordial is oocyte (primary sex cell) which is surrounded by dark **sused shape** nuclei and here it is single layer and these are called follicular, come from surrounding cells tissue follicle.



## Primordial germ cells

give rise to gametes

Appear in the wall of the yolk sac

migrate along the allantois

to the dorsal mesentery of the hindgut

✓ into the gonadal ridges

become associated with the primary sex cords

In the female

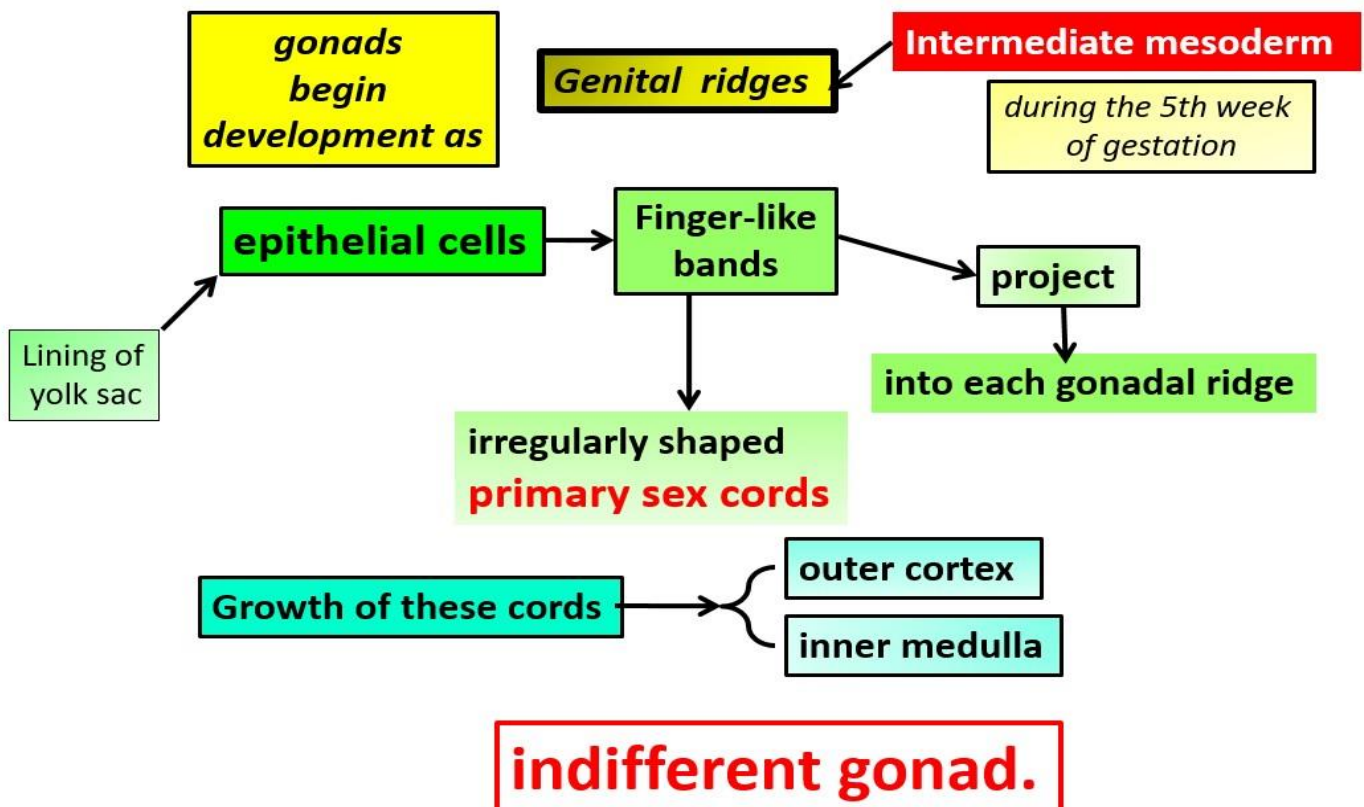
become oogonia

divide by mitosis during fetal life

No oogonia are formed after birth

If the primordial germ cells fail to migrate to the genital ridges

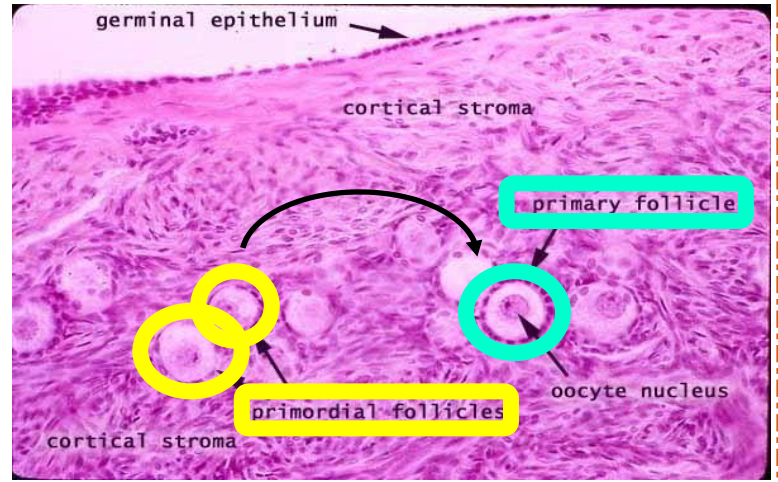
the ovary does not develop.





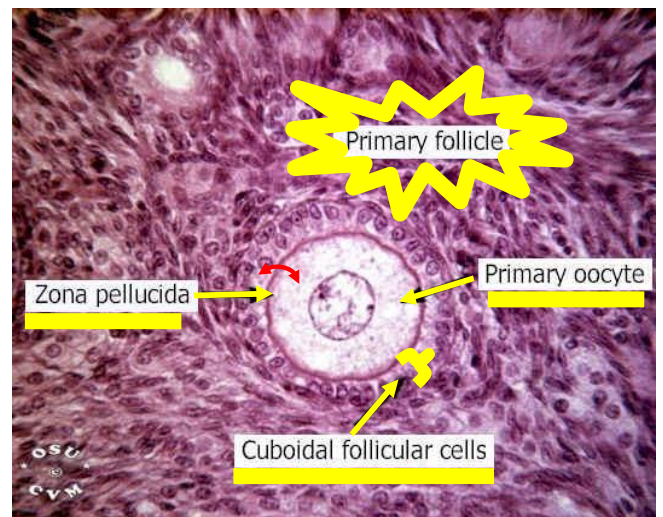
➤ This is true histological section of the cortex of the ovary.

- If you notice follicle inside this yellow circle you can find clear cytoplasm, whitish area and the nucleus in the middle this is a very early oval cell and it is surrounded by **single layer** of thin cells called squamous cell.
- How many layers are there? Single layer.



- There is another e.g. it is containing an ovum and it surrounded by single layer of thin cell ,it is thin because these dark cell which represent the nuclei of the surrounding cell ,these are feature of primordial follicle ,these are the very early stages of the development.
- look to other follicle you can see the ovum or oocyte is larger and the surrounding cells are not thin because the nuclei are not like simple line ,nuclei of surrounding cells are cuboidal like cube ,these the feature of next stage of developing of primordial follicle now it is primary follicle.
- comparing between ovum surrounding by single layer of thin cell &ovum at the top of curved arrow you can see a difference between single layer lining of primary follicle and single layer flat cells surrounding the oogonium.

➤ Another histological section of the cortex of the ovary. At large follicle in the middle you can see the oocyte ,it is primary because the surrounding cells are cuboidal there are not flat ,cuboidal mean 2 dimension of cells are equal, the dark line surround the ovum which is glycoprotein material secreted by both the ovum and follicular cells and it is zona pellucida.





primary follicle

The oocyte enlarges

has two layers of follicular cells

become known as 'granulosa' cells

form many layers surrounding the oocyte

arrested at an early stage of the first meiotic division

**zona pellucida.**

thick glycoprotein layer

between the oocyte and the zona granulosa

meiosis 1



10th week

undifferentiated gonad

✓ developed into an identifiable ovary

Primary sex cords degenerate

secondary sex cords

cortical cords appear

from the surface epithelium

into the underlying mesenchyme

organize into primordial follicles

Primordial follicles



oogonium



a **single** layer of squamous follicular cells from the cortical cords

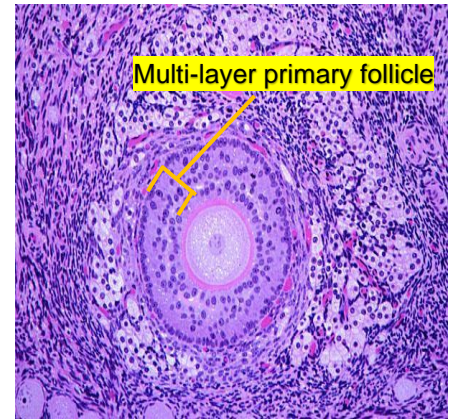
diploid

**Zona pellucida**

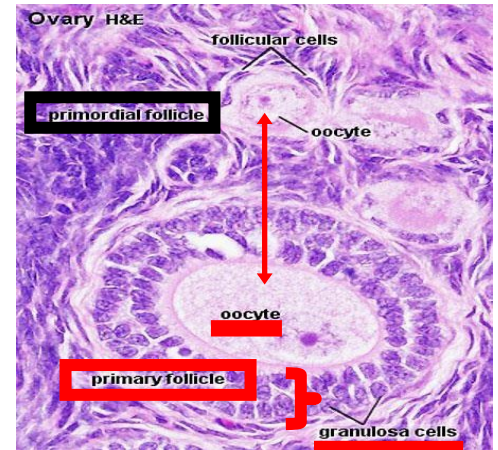


➤ **Meiosis I:**

This is a section of ovary in which you can see the granulosa cell are multilayer and it called multilayer primary follicle.

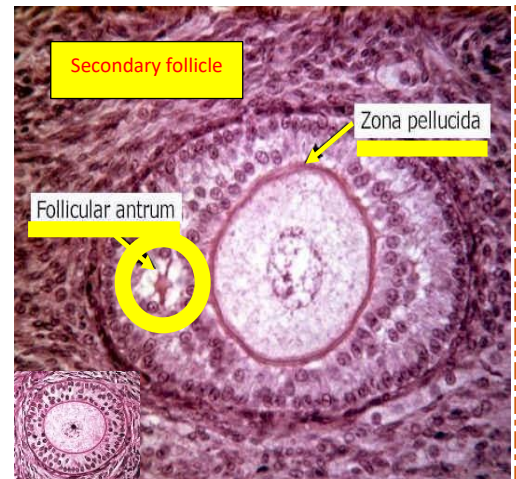


➤ Here you can see an oocyte surrounded by zona pellucida and the granulosa cell are multilayer with large nuclei and these are granulosa cell come from the surrounding tissue of the oocyte and there for it is multilayer primary follicle, while if you go up you can see primordial follicle where it is having smaller oocyte and there is no zona pellucida and it surrounded by single layer of flat cell.

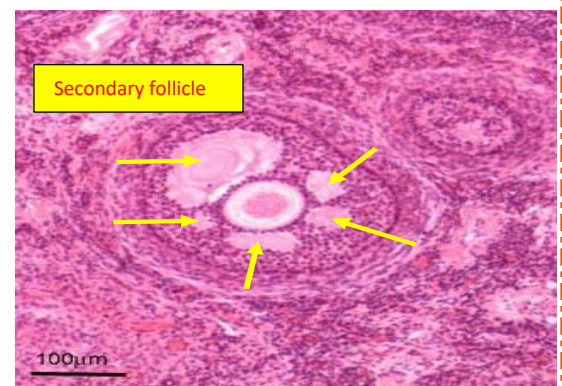


➤ **What kind of follicle is this?**

It is multilayer primary follicle but if you look at the top of yellow arrow you can see that there is an attempted of forming small space this is very small space and called small antrum, this development is going to change the name of this follicle from primary follicle into secondary follicle.



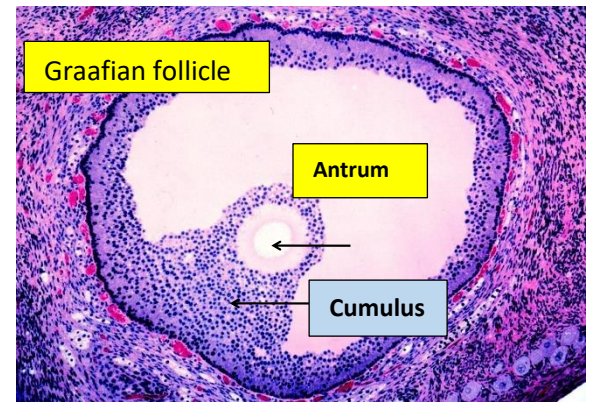
➤ A secondary follicle because of present of vacuole containing fluid in zona granulosa. Little space get larger and larger and more space are developing in zona granulosa.





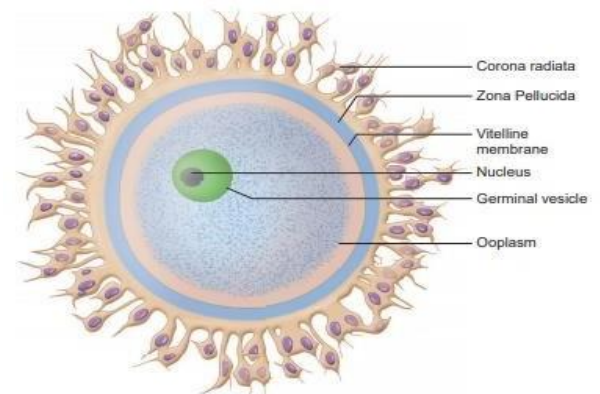
➤ Here The last stage of developing of oocyte in its follicles which is **graafian follicle**.

- Here you can see the little spaces has united together form a large single cavity filled with fluid which is important of the nourishment of the oocyte.
- This is last stage of developing follicles.
- The black arrow indicate the oocyte and this arrow bellow it is pointed at the granulosa cells that connect the oocyte to the granulosa cells making the periphery of the antrum ,this number of granulosa cells are called cumulus (granulosa cells of the cainterna connecting the oocyte to granulosa cells).



➤ **Expelled oocyte with its covering:**

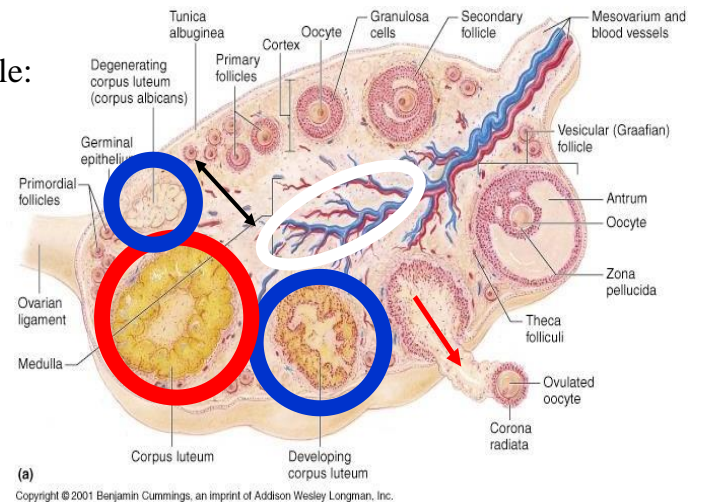
- The surrounding cell of the oocyte are the corona radiata these are granulosa cells on the out , then the zona pellucida inside zona pellucida thin layer of jelly material called vileline membrane then oocyte ,the cytoplasm then the nucleus of oocyte(called the germinal vesicle coz it is going to divide).
- The nucleus 1n half number of chromosomes.



**Fig. 2.8 (b) Diagrammatic view of the human ovum**

➤ Cross section of ovary the primary sex organ in female:

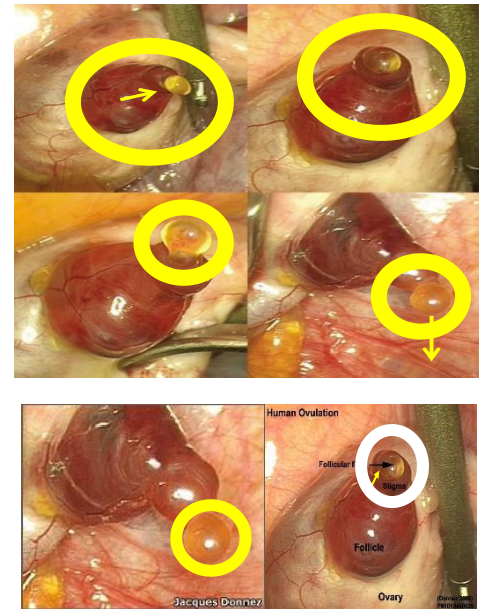
- when the oocyte being expelled these event happen in the cortex and at this event granulosa cells remain in the cortex which are hormones secreting cells,these cells start to secrete hormones much earlier than this event and it becomes functional and this is what is called developing corpus luteum(the remain of granulosa cells) and when it develop& establish structure yellow in color and this is fully functional granulosa cells and it is called corpus luteum.
- If pregnancy is happening this corpus luteum is going to stay active and secreting estrogen and progesterone to promoting pregnancy.
- If fertilization does not happen there is no need for corpus luteum it is going to atrophy mean it stop functioning and it get smaller and this is the last nonfunctional corpus luteum it called(Scar) corpus albicans(the degenerating functional corpus luteum).



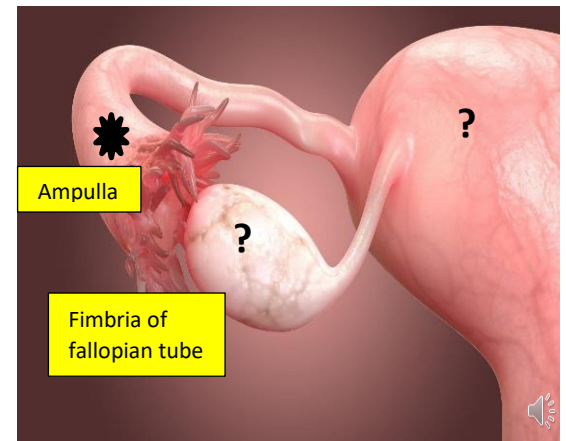
Copyright © 2001 Benjamin Cummings, an imprint of Addison Wesley Longman, Inc.



- This group by laparoscopic photographs.
  - What is laparoscopy?  
an instrument putting on the abdomen through an incision and shining a light and watching the structure live.
  - In this image you can see the **red bulging area** which is a very distended to rupture in Graafian follicle.
  - Second image to your left there is an oval yellowish structure protruding from a point this is the oocyte coming out of the Graafian follicle.
  - 3<sup>rd</sup> image the oocyte going to separate from the Graafian follicle.
  - The lower right image the oocyte is going to be falling down from the ovary.

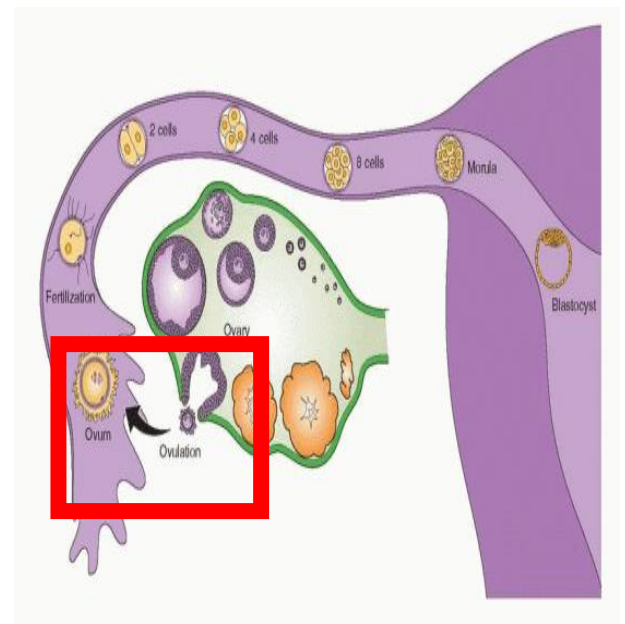


- These arm come from last part of fallopian tube or uterine tube trying to surround the ovary so when ovum is from out these fimbria will catch the ovum and take it in. after fimbria there is this structure of fallopian tube called the ampulla in it fertilization will take place.
- Fertilization is fusion of oocyte with the sperm.



### ➤ Diagram of uterus uterine:

- In the triangular the Graafian follicular has ruptured and the oocyte dropping down, then oocyte it has to be caught by fallopian tube if the fimbria of the fallopian tube are not functioning then this oocyte will drop down in the pelvic.
- If the oocyte caught by fimbria the sperm will be arriving and fertilization will take place.

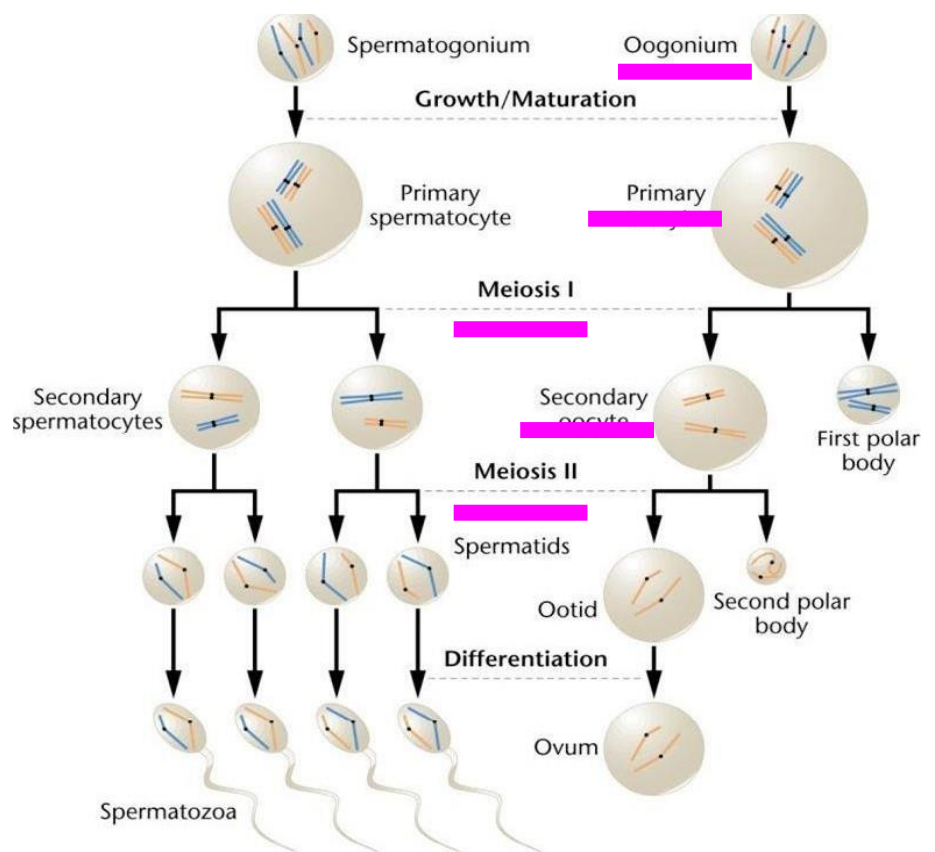


- This structure inside the fallopian tube and lining membrane inside it, when the oocyte enter the fallopian tube the extension of the lining of fallopian tube (cilia) they move beating things from the ovary from the fallopian tube to the uterus.



- Here is a diagram of what happen in cases of development of the oocyte :

- It start as oogonium and it has full set of chromosomes then it is get larger and surrounded by follicular cell(called the primary oocyte).this primary oocyte which is full set of chromosomes has  $2n$ , meiosis I is going to start here and going to stop at prophase and then when reaching puberty the primary oocyte will change into secondary oocyte by changing the shape of follicular cells and it is trying to become  $1n$  and here meiosis II is going to be completed puberty before fertilization.



# Spermatogenesis

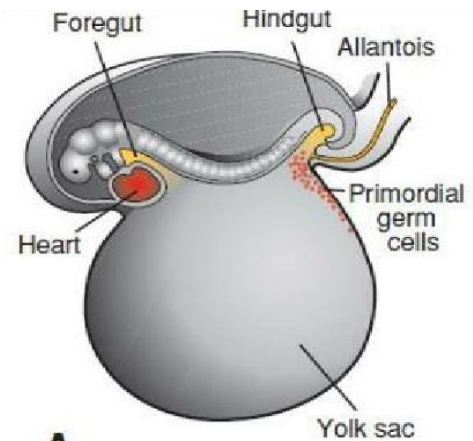
This is the international expected symbol of the male sign

The development of male gametes:

In this picture we see the embryonic disc where the future human being is going to develop from this disc, and there is a cavity above this disc filled with fluid above this disc called **amniotic cavity**.

And there is a cavity under this disc called the primary yolk disc this sac filled with fluid for the sac of nutrition of the embryo the same as above cavity amniotic cavity.

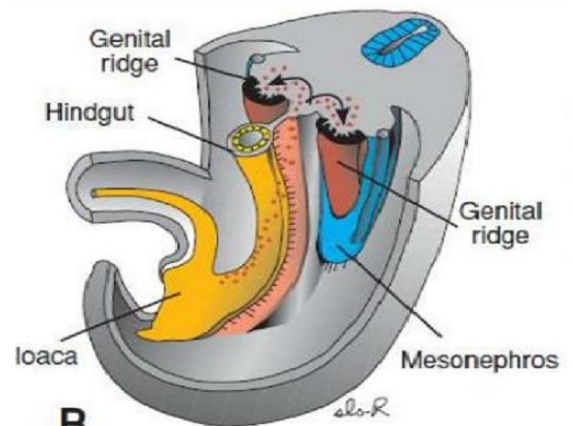
In the wall of the yolk sac near this yellow marked extension of the yolk sac is called the allantois, these cells are coming from the lining of the yolk sac and they are the starting cells of developing human body and they called primordial germ cells.



**A**

The primordial germ cells developing around allantois they are going to travel to genital ridge, through what?

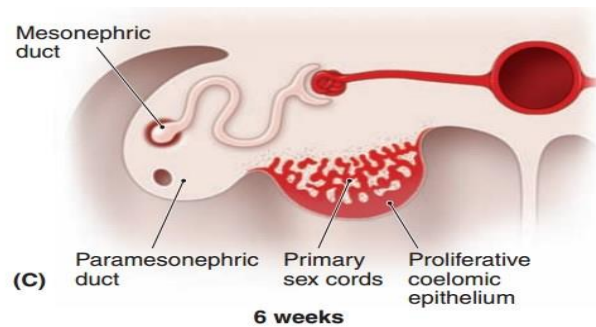
It is going to take the surface of the nearest structure which is the last part of the developing large intestine and they travel through the wall of this part of the intestine along with the structure attaching it to the abdominal wall which is called **mesentery** and then reach the genital ridges: one on the right and one on the left.



**B**

from this picture

in 6<sup>th</sup> week of intrauterine life if we look at the genital ridge, we can notice that these red areas are due to proliferation that is growing into and expanding the epithelial cells from the yolk sac and when these cells grow into the genital ridge, they don't go in as a solid mass of cells but as irregular cords of cells and these are called **primary sex cords**.



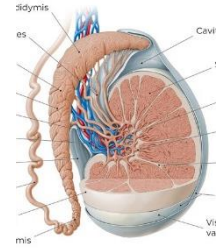
**(C)**

6 weeks



## The testes

This is the fully grown mature testes, it has different parts and there are a quite difference from the parts of the ovary.



This image shows that the testes in its adult position is down at the bottom of the scrotum which is a pouch of skin in the perineal area ready to recede the testes because the testes need lower temperature than the temperature of the body (the temperature inside the body not that of the skin), why?

Because this is what the development of the sperms requires.

The testes at the bottom of the scrotum are connecting to the body through a cord called **spermatic cord** which contains **arteries, veins, nerves, lymphatics, and the vas deferens** the passages of the sperms from the testes to the inside of pelvis this spermatic cord passes through the layers of the anterior abdominal wall and then gets into the pelvis and the vas deferens going to have minor additions of a gland called **seminal vesicles and then they end up into ejaculatory ducts two of them and then they empty into the prostatic urethra.**

The outer cover of the testis is made of dense connective tissue called **tunica albuginea**.

This **tunica albuginea** send fibrous projections that separate the testis into incomplete lobules called **septa**

The incomplete lobules contain 1-4 convoluted seminiferous tubules and, in the testis, we have 200-300 convoluted seminiferous tubule.

Straight seminiferous tubule which is the last part of the seminiferous tubule that translocate the sperms into the rete testis.

Rete testis it is a network of passages in the middle of the testis.

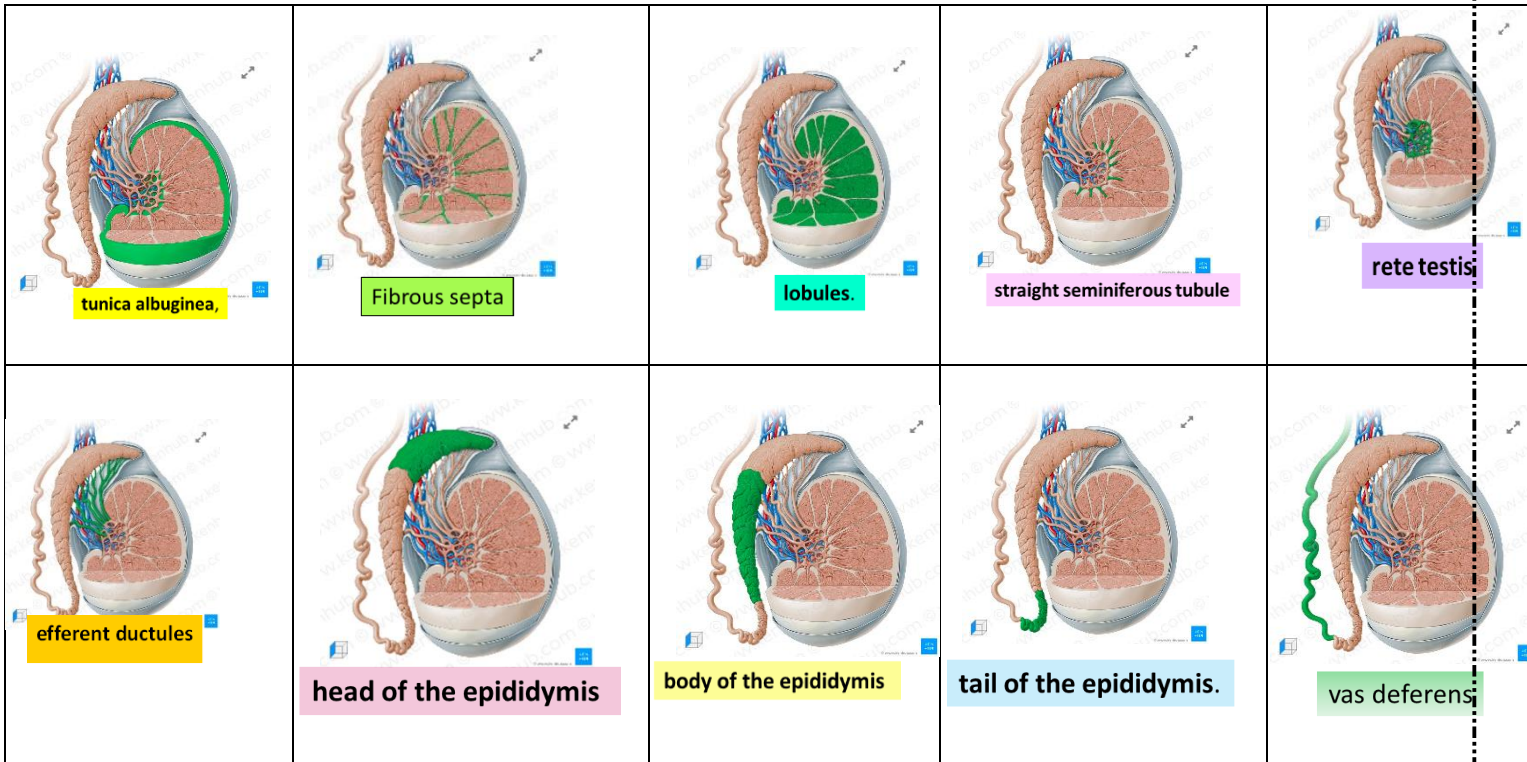
Efferent ductulus also called straight ducts, there are 12 – 20 efferent ductulus in the testis.

Epididymis → 6m in long but it occupies a small space, posterior to the testis, it receives the efferent ductulus , it consists of 3 parts:

1. Head
2. Body
3. Tail

The epididymis is connected to tube that take the sperms away from the testis which is called **vas deference** which is connected to the spermatic cord which passes through the abdominal wall muscles to get into the pelvis and empty into the prostatic urethra.

The vas deference joins with the seminal vesicles to form the ejaculatory ducts.

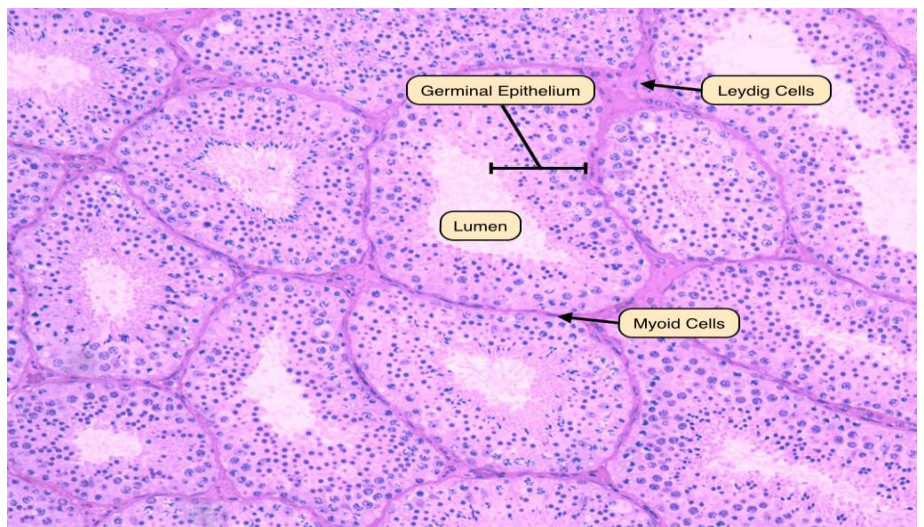


The seminiferous tubules are much longer than the space that occupying therefore it becomes very much packed so that they are very close to each other **بتكون مرصوه على بعض**.

Each seminiferous tubule will have lumen where the mature sperms will pass through these lumens.

There are thickness of cells called germinal epithelium (germinal → because it contains cells that are dividing)

Leydig cells which are located **between the seminiferous tubules** and secretes the **hormone testosterone**.



The seminiferous tubules have a wall consists of myoid cells that make the outer shell.

The germinal layer consists of cells that will form the sperm → the cells of this layer will tell the story of the beginning of the conversion of the spermatogonia to spermatids and then to sperms.

Myoid means muscle so that the myoid cells are composed of smooth muscles , fibrous tissue , blood vessels and other types of cells.

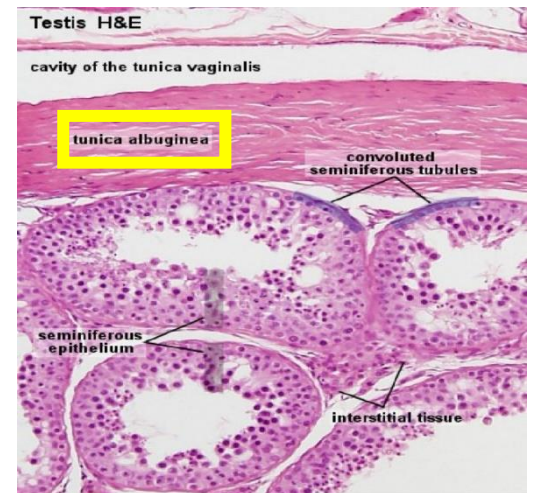
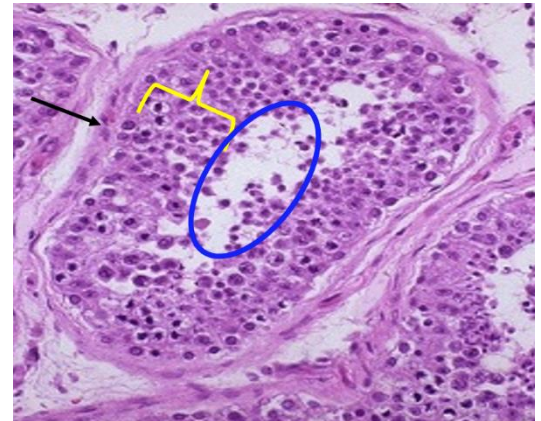
At the periphery of the testis, we have the tunica albuginea and in the cross section of the semiserious tubules we have myoid cells, lumen, and germinal epithelium.

The germinal epithelium tells us the story of spermatogonia up to formation of spermatids then the sperms.

The story start with each of the wall of the semiserious tubules that contain smooth muscles , fibrous tissue , blood vessels and other types of cells that will go to surround the structures of the semiserious tubule.

At the periphery we have cells that are **small with dense nucleus** this cell called spermatogonia that represent the first stage of development .

Then , we have **large cells** where the chromosomes are going to disperse شتت and cells are divide very rapidly and it called primary spermatocytes that will develop into secondary spermatocyte.



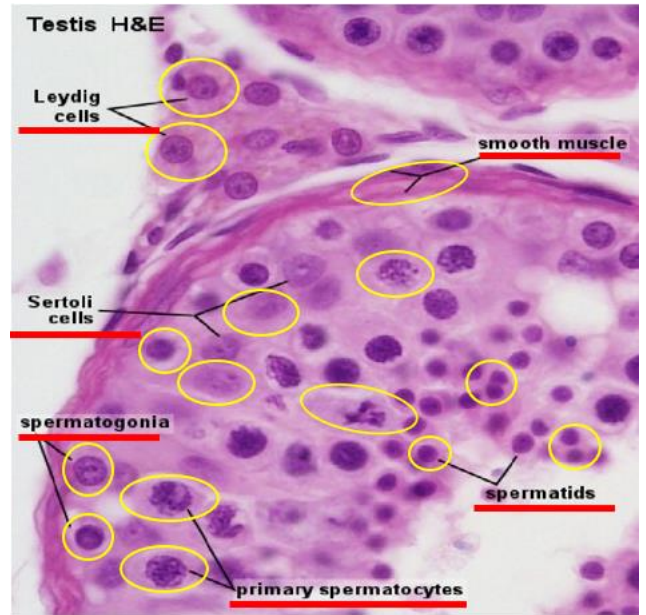


Secondary spermatocyte it is one of the cells that has **half number of chromosomes** and they are very difficult to see because they divide very quickly.

Why very quickly? Because we want to generate very high number of sperms (may be reach to 1 million) but this process needs a lot of energy.

The germinal cells need energy in very high levels so it needs nourishment and the cells that responsible for nursing the cells called **Sertoli cells** which is a large cells have faint **خافت** and large nucleus so that I can recognize it very easily.

Then the secondary spermatocytes are going to develop into spermatids which is the early stage of the mature sperms, these spermatids' nuclei are very near to the lumen of the semiserious tubules and they are very **small and darked color**



these cells include the serious of spermatogenesis process starting from the spermatogonia and ending with spermatids.

Near the myoid cells we have **the spermatogonia** contain **dense nucleus** and it locates near the periphery, and they are always away from the lumen.

Primary spermatocytes dividing by **miosis I** continually because we want millions of sperms, it is located next to the spermatogonia (most of the time we in the stage of mitosis!!!)

Secondary spermatocytes → are difficult to find because of the very quick division.

Spermatids which is very nearer to the final shape of the sperm and they have condensed and small nucleus it is located very near to the lumen.

Sertoli cells it has a pale nucleus, its main function to nursing the germinal cells. The cells that produce the testosterone are called the Leydig cells located **between the semiserious tubules**, it is large cells and contain granules.

The Sertoli cells are extending from the myoid cells to the lumen and it has the largest nucleus in the semiserious tubules.

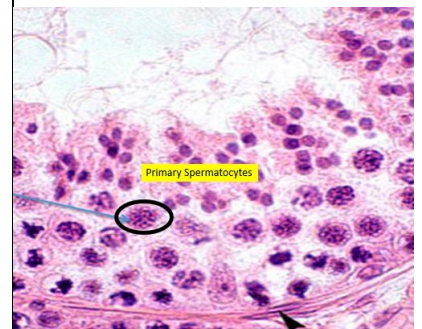
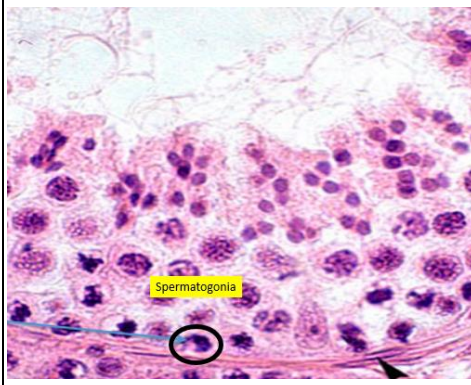
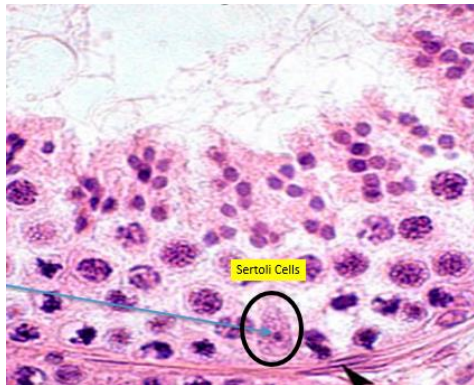
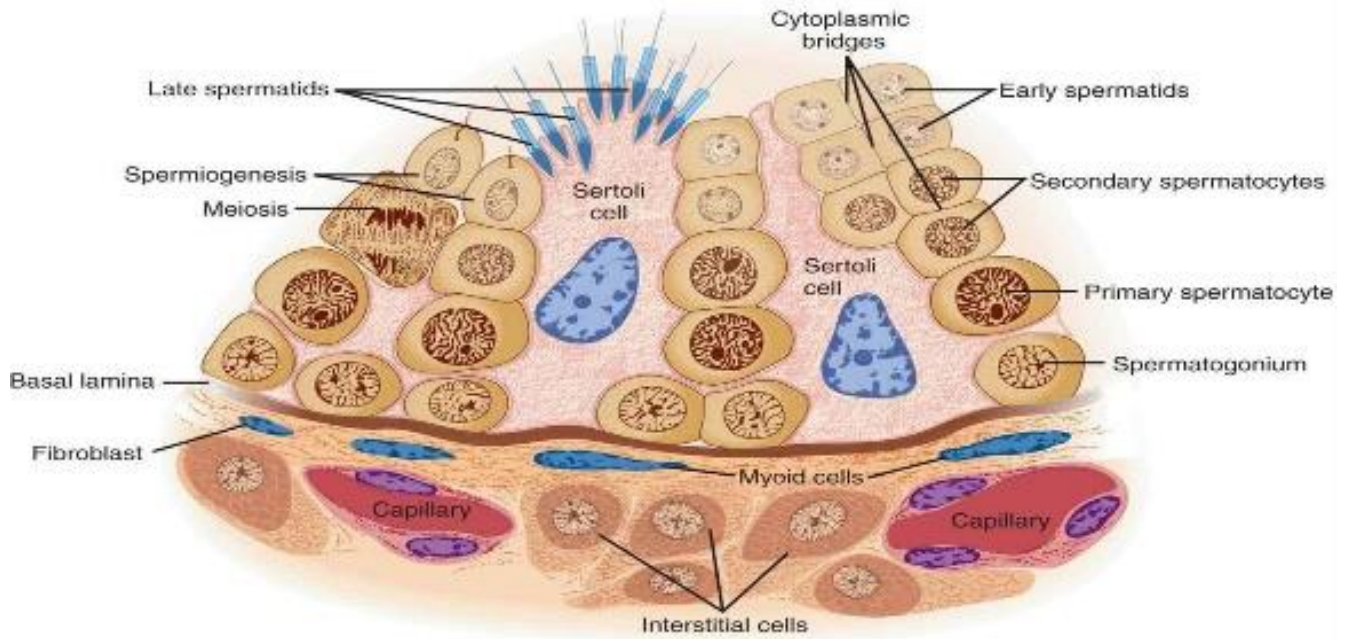
The spermatogenesis process:

The spermatogonia setting at the periphery then the primary spermatocytes then the secondary which is near to the lumen , and its density of chromosomes is **lower** than the density of primary spermatocytes' chromosomes then **early spermatids** which is the very early of forming the spermatids.

The spermatogenesis is a process when the spermatids change its shape and structure to form the sperm.

The interstitial cells are the Leydig cells that surrounded by capillaries and secretes the testosterone that go to these capillaries.

CHAPTER 23 Function of the Male Reproductive System

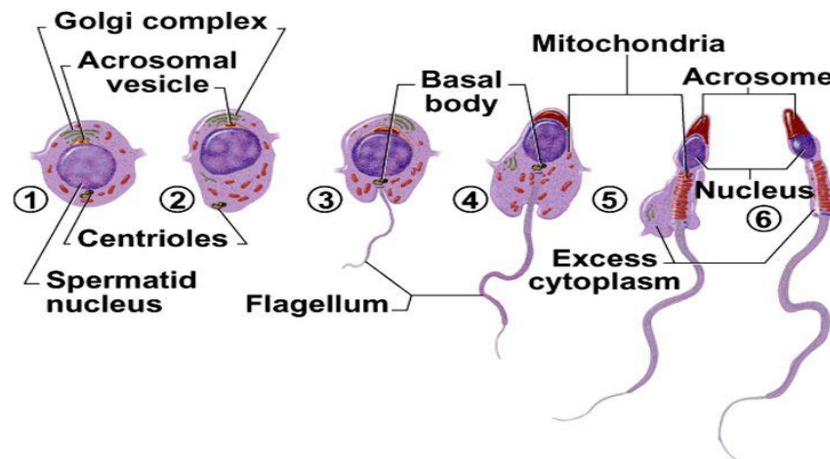


The spermatids which are the very initial shape of the sperm and they need to change to a shape that is capable of migration through the female and male genital systems, it is located near the lumen.

The process of change of the shape of spermatids into sperms called **spermiogenesis**.



## Spermiogenesis



- Changes that transform spermatids into spermatozoa
  - discarding excess cytoplasm & growing tails

In the above figure :

At the structure number 1: a round cell with nucleus which is very important because it holds the genetic material and it contains some cellular **organelles** which are important because we need to produce structure called **acrosome**.

**The acrosome** is made of enzymes that we need to form an initial acrosomal vesicles to form it.

At the structure number 2: acrosome is going to be larger and collect more enzymes and then at the bottom of the cell (structure number 2) you will find something called centrioles which is an anchoring structure, and it is usually seen in the stages of meiosis and mitosis because they form a center and chromosomes will be pulled towards that centriole.

At the structure number 3: we have a moving structure which is flagellum that is a cellular extension attached to the centriole, it is the **motor of the sperm** that pushes it forward in the process of migration.

At the structure number 4: the acrosome is developing more and more and the flagellum is getting longer



At the structure number 5: acrosome will take its final shape on the top of the nucleus the very front end in the head → down of the head we have sac that contain mitochondria → which is **very essential** because it is the power-hose of the sperm that provide energy to move the flagellum.

Essential parts of the sperms → acrosomes + nucleus + mitochondria + flagellum + excess of cytoplasm → this is the finished away and disscarbied .

At the structure number 6: final shape of the sperm

# The END

Don't hesitate to ask any question.

*Your talents and abilities will improve over time, but for that you have to start..*