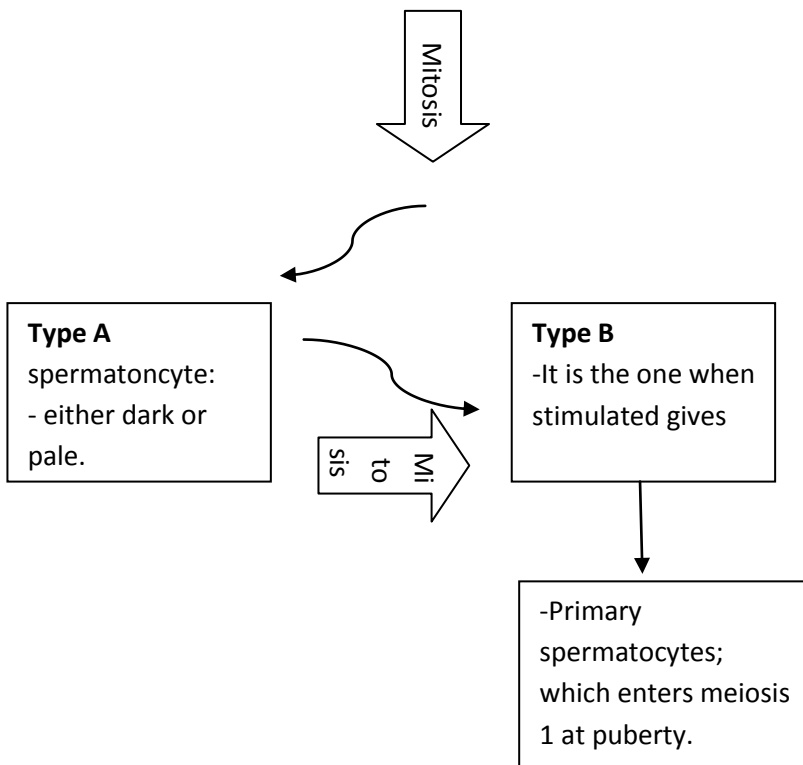


Oogenesis

A revision for the last lecture ...

Spermatogonium ($2n$):

-Originated from primordial germ cells



Notes:

- meiosis in males starts at puberty age which differs from oogenesis.
- meiosis in seminiferous tubule from type B spermatogonium which changes into primary spermatocytes, enters meiosis1 at puberty age.

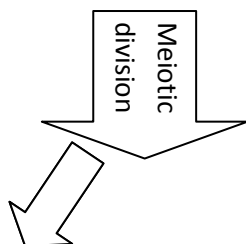
Spermatogenesis



Primordial germ cells



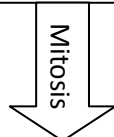
Spermatogonium



Type A doesn't
enter meiosis



Type B (2n)



Primary
spermatocyte (2n)



Meiosis I

Secondary
spermatocyte (1n)

Secondary
spermatocyte (1n)



Meiosis II

Spermatids
(1n)

Spermatids
(1n)

Spermatids
(1n)

Spermatids
(1n)

-The nuclei of these sperms contains 23 single chromosomes (22 autosomes , 1 sex chromosome).

At the end of the spermatogenesis we will have 4 sperms:

2 contain X chromosomes and 2 contain Y chromosomes.

- Oogenesis occurs in the ovary.

*In a cross section of the ovary we notice that:

- 1- at the edge of the surface there are (surface epithelial cells)
- 2- under the surface epithelial cells there are germ cells which came from the wall of the yolk sac of the embryo at the forth week and they reach the surface of the ovary at the 5th week.
- 3- there are blood vessels (arteries + veins) enter via the ovarian ligament.
- 4- the ovarian ligament stabilizes the ovary in the ovarian fossa in the pelvis.

*Differences between oogenesis and spermatogenesis :

- 1- when the germ cells reach the surface they are surrounded by one layer of follicular (epithelial) cells which are simple squamous at the beginning. And then it is transformed into simple cuboidal epithelial. And these surrounded germ cells are called **primordial follicles**.
- 2- these primordial follicles undergo mitoses when reaching 5th week just like spermatogonia.
- 3- the nucleus in the primordial cells are called **oocyte** or **oogonia**.

-at the 5th month the embryo has a maximum number of 2 million oogonia produced by mitosis (which means that every follicular cell produces 2 daughter cells each contains 46 chromosomes 2n).

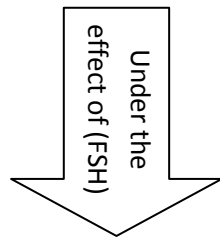
- these oogonia undergo degeneration (shrinkage) and these degenerated cells are called **atretic cells** as a result of this degeneration.

- the number of oogonia is reduced to 400.000 at birth.

-Before birth the oogonia undergo meiosis I and produces primary oocyte which becomes arrested at prophase of meiosis I (diplotene or arresting stage) and the division stops until puberty age.

-At puberty age (15 years old) the secretion of follicular stimulating hormones (FSH) from pituitary gland. starts

*Primary oocyte (arrested at prophase of meiosis I)



The division completed (just 5-15 are stimulated and only one becomes mature)

*each month ONLY one cell becomes mature.

*so 12 mature ovum a year

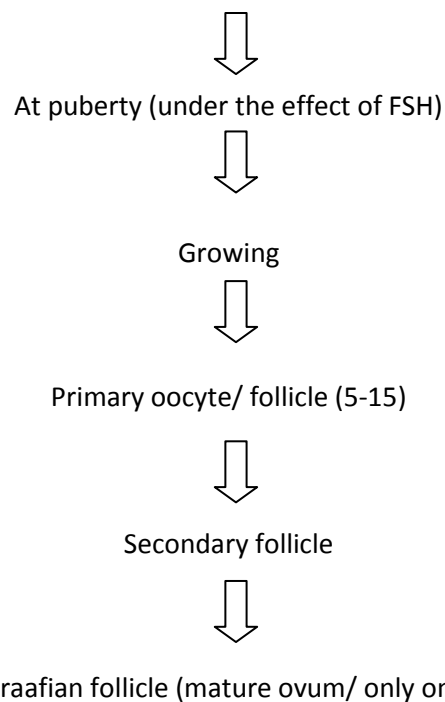
*if menopause at 55 years old, then how many cells are produced?

- 480 or 500 from both ovaries. $(12 * (55-15) = 480)$ (240 or 250 from each ovary).

*at birth 400.000 but only 500 become mature and the rest degenerate.

*maturation production..., only one each month...(graafian follicle.)

Primordial follicle (one single layer of simple cuboidal epithelial cells)



*if there is a bulge on the surface of the ovary, then it is the ovulation time, which is usually at the 14th day from the beginning of menses.

***ovulation:** the release of the mature ovum from the ovary.

Then the mature ovum is caught by the fimbriae of the fallopian tube into the ampulla of the tube and it stays there for (24 to 48) hours .

►
Before the ovulation it ends meiosis ONE and enters meiosis 2 .

**** there is a secondary arresting stage (diplotene stage) at metaphase of meiosis 2 where the division stops ..**

When meiosis II is continued ?

If fertilization occurs (the ovum is penetrated by the sperm) and fusion of nucleus of ovum with the nucleus of the sperm to form the diploid cell “ zygote “

A quick revision

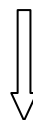
Premordial germ cells

Mitotic divisions



oogonia

2-7 million



further division & degeneration , many cells become atretic “ degenerated “ so that their number is reduced to 400,000 at birth

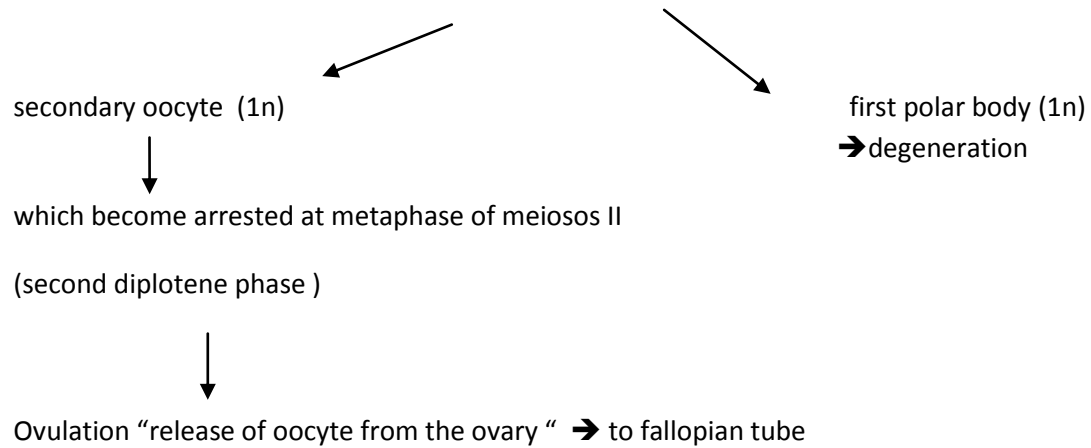


primary oocytes arrested at prophase of meiosis I (first diplotene phase)

continuation of meiosis I occurs at puberty age under the effect of (FSH) which stimulates certain number of cells (5-15) every month , before ovulation .

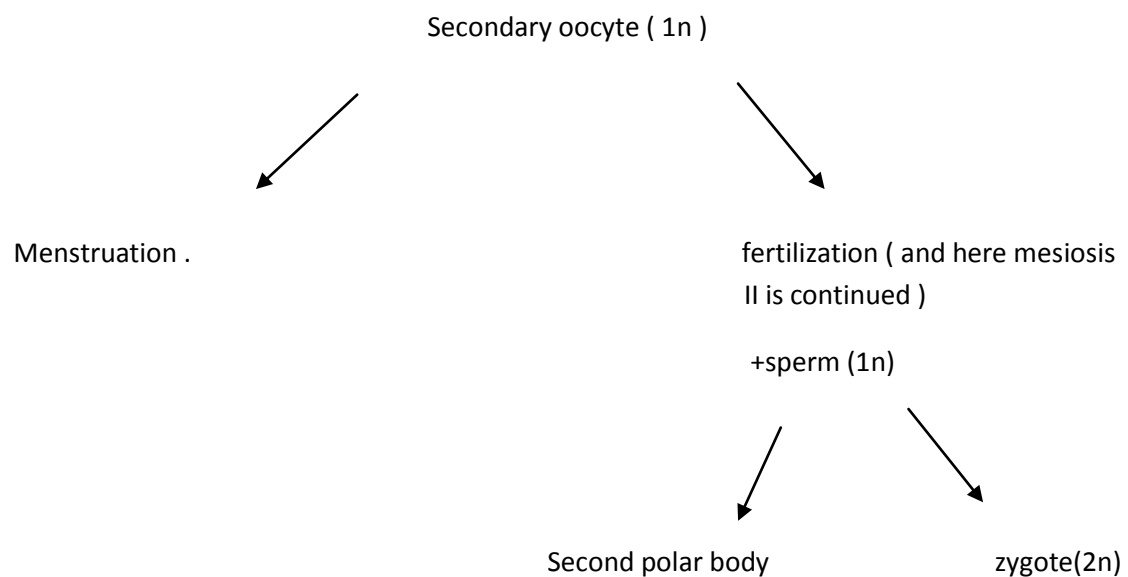
meiosis I





Fate of secondary oocyte :

After ovulation if there are sperms in fallopian tube then fertilization occurs and the ovum is penetrated by a sperm and zygote is formed ,Otherwise disintegration occurs " menses " .



- at the end of the 3rd month the oogonia clusters under the surface epithelium.
- all oogonia in one cluster are derived from one single cell.
- flat epithelial cells are known as follicular cell.
- by the 5th month prenatal the number of primary oocyte is (2-7 maximum) million oogonia.

- most of these cells undergo degeneration (cell death) and become atretic cells
- by the 7th month the majority of oogonia have degenerated except a few near the surface
- at birth the number is (500,000-700,000) , (400,000 the minimum)
- just 500 undergo ovulation
- at birth, no germ cells and no oogonia they are all primary oocyte now (there is meiosis II)
- why are these primary oocytes arrested at prophase of meiosis I ?

Answer: because of the secretion of a protein called (OMI) (oocyte maturation inhibitor) which inhibits and arrests all primary oocyte at prophase till puberty.

-at puberty age, under the influence of (FSH), the influence of OMI on few cells (5-15 cell) is inhibited every month. And these cells develop while the other ones "the majority" remain arrested .

-Some Women at the age of 55 years old have some arrested primary oocytes and as the age increases ,the primary oocytes at the arrested stage increase under the effect of outer circumstances "they are affected genetically", like drugs and smoking. And this increases the probability of chromosomal abnormalities.

*the doctor talked about a study on ovary about the changes of germ cells (slide 5).

-total primary oocyte at birth vary (700,000-2 millions)

-during childhood most of them become atretic and there is approximately 400,000 by the beginning of puberty.

-some books said there are 400,000 at birth.

- fewer than 500 will be ovulated (like 480: 250 to 240 from each ovary).

-whether the cresting stage (diplotene) protects against environmental influence is unknown.

-after menopause, same cresting stages is still found.

-having a child which chromosomal abnormality increases with increasing maternal age. So primary oocyte are vulnerable to damage even at diplotene stage.

*at puberty the increased growing of follicles is continuously maintained from the supply of primordial cells.

*the follicular cells are flat (simple squamous) at first then they change into simple cuboidal.

*the surrounding epithelial cells divide by mitosis to form corona radiata.

*zona pellucida is a protein membrane surrounding the oocyte which is synthesized by nucleus of the oocyte itself and the surrounding follicular cell.

*the function of zona pellucida :

-protection of oocyte

*when does zona pellucida disappear ?

-after implantation (exactly in the 5th day) the stages of primary oocyte at puberty age :

1- preantral /primary : (which is formed before the formation of the antral)
the antral is the space inside the graafian follicle.

2-secondary or antral or vesicular or graafian : where the antral is formed.

3-preovularity: before the ovulation of graafian follicles.

*by vesicular we mean there are vesicles or spaces.

The antral stage is the longest, whereas the preovulatory stage encompasses approximately 37 hours before ovulation.

-granulosa cells arise from follicular cells by mitotic divisions

As the primary oocyte begins to grow, surrounding follicular cells change from flat to cuboidal and proliferate to produce a stratified epithelium of **granulosa cells, and the primary unit is called a primary follicle**

*the doctor was describing a picture/ slide 8

_follicular antrum.

-zona pellucida which surrounds the primary oocyte

-basement membrane(BM) for granulosa cells

-outside this BM there are theca interna and theca externa the external part.

-the changes that occur in the primary oocyte is the formation of
:

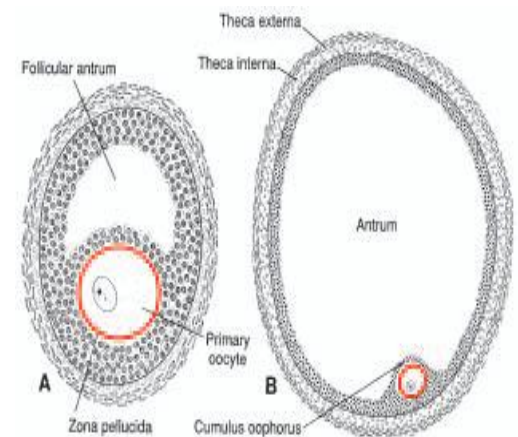
1-zona pellucida

2-follicular cells: by mitosis granulosa (stratified epithelial with basement membrane separating it from thecal cells (theca interna & externa)

*theca interna is directly attached to BM

*the antrum= (follicular space)

*granulosa cells rest on BM separating it from the surrounding stromal cells that form theca follicular cells.



-granulosa and oocyte secrete layer of glycoprotein which form the zona pellucida

- we previously mentioned that zona pellucida is formed by the oocyte itself and there granular cells.

-the follicles continue to grow and theca follicles organize to form theca interna and theca externa.

-the antrum enlarges and become filled with fluid to provide nutrition for the oocyte .

****characteristics of graafian follicles**** (mature graafian follicle or mature ovum) :

1-the antrum takes its maximum size with fluid

2-outer surfaces are : 1-theca interna, 2-theca externa, 3-BM

4-granulosa cells.

-the cells that surround zona pellucida from outside are called (**cumulus oophorus**)

-the cells that are directly attached (first row around zona pellucida)are called corona radiata.

-all of them are originally granulosa cells but:

*the part that is surrounding ovum is called (**cumulus oophorus**)

* the first row surrounding the zona pellucida is called (corona radiata).

A question : is the cell inside primary or secondary?

-answer: before ovulation it reaches the max size so it is sec. (the primary finishes meiosis I and it gave secondary and polar body).

Characteristics of secondary follicle:

(25) mm in diameter

*It is surrounded by the theca interna, which is composed of cells having characteristics of steroid secretion, rich in blood vessels, and the theca externa, which gradually merges with the ovarian stroma

*each ovarian cycle number of follicles which begins to develop and only one reaches full maturity, the other degenerates.

*now , the secondary follicles(mature): here the LH(luteinizing hormone) reaches its max level which is called surge

-surge: is the max level of LH.

-Meiosis I is completed producing 2 daughter cells: secondary oocyte & one polar body and they both have 23 single chromosome but double structure of DNA.

First polar body -----→ gives second division

Two polar bodies -----→ disintegration

Ovulation is for secondary oocyte surrounded by (zona pellucida granulose cells)

While thecal cells (interna and externa) remain in the ovary

* we notice on the surface of the ovary there is a blood clot which means that there is bleeding with ovulation

And this gives a hint to the site of ovulation . * when fusion occurs between the nuclei of a sperm and a mature ovum , it completes meiosis 2 to form a zygote .

Keep in mind:

The secondary oocyte remains 24-48 hours and if there is no fertilization it's is disintegrated

Good Luck!

Written by : Hadeel Sami ☺

Corrected. ☺