

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ
الْحَمْدُ لِلَّهِ الَّذِي
خَلَقَ السَّمَوَاتِ وَالْأَرْضَ
وَالَّذِي جَعَلَ الْمَوْتَ
وَالْحَيَاةَ وَالَّذِي
يُحْيِي الْمَوْتَى
وَالَّذِي يُخْرِجُ
الْحَبَّ وَالذُّرْءَ
وَالَّذِي يُصَوِّرُ
الْبَشَرَةَ فِي أَحْسَنِ
تَقْوِيمٍ
سُبْحَانَ اللَّهِ عَمَّا يُشْرِكُونَ
اللَّهُ أَكْبَرُ
عَمَّا يُشْرِكُونَ

O O G E N E S I S

DRAMBEREEN

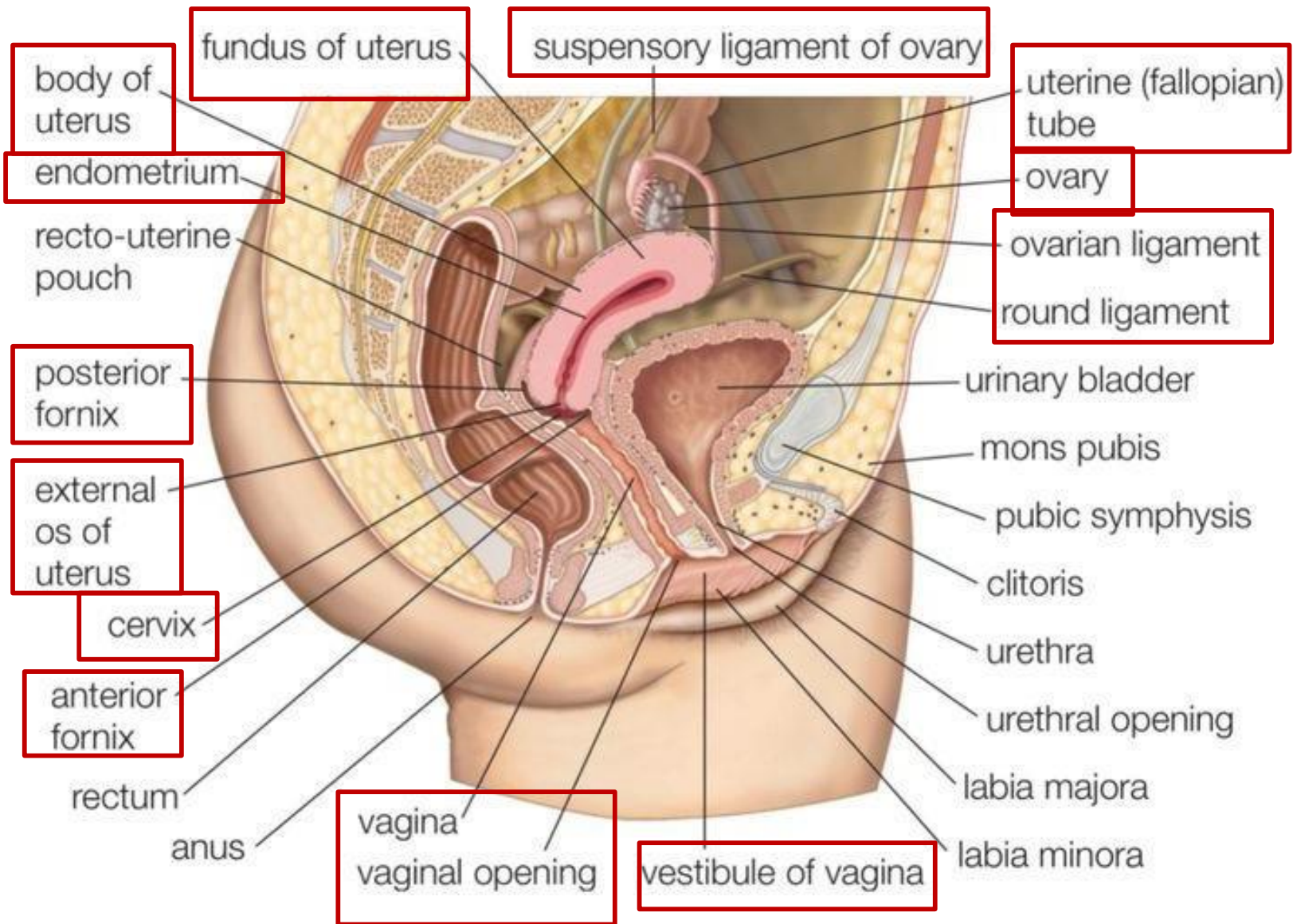
HUMAYUN

OOGENESIS

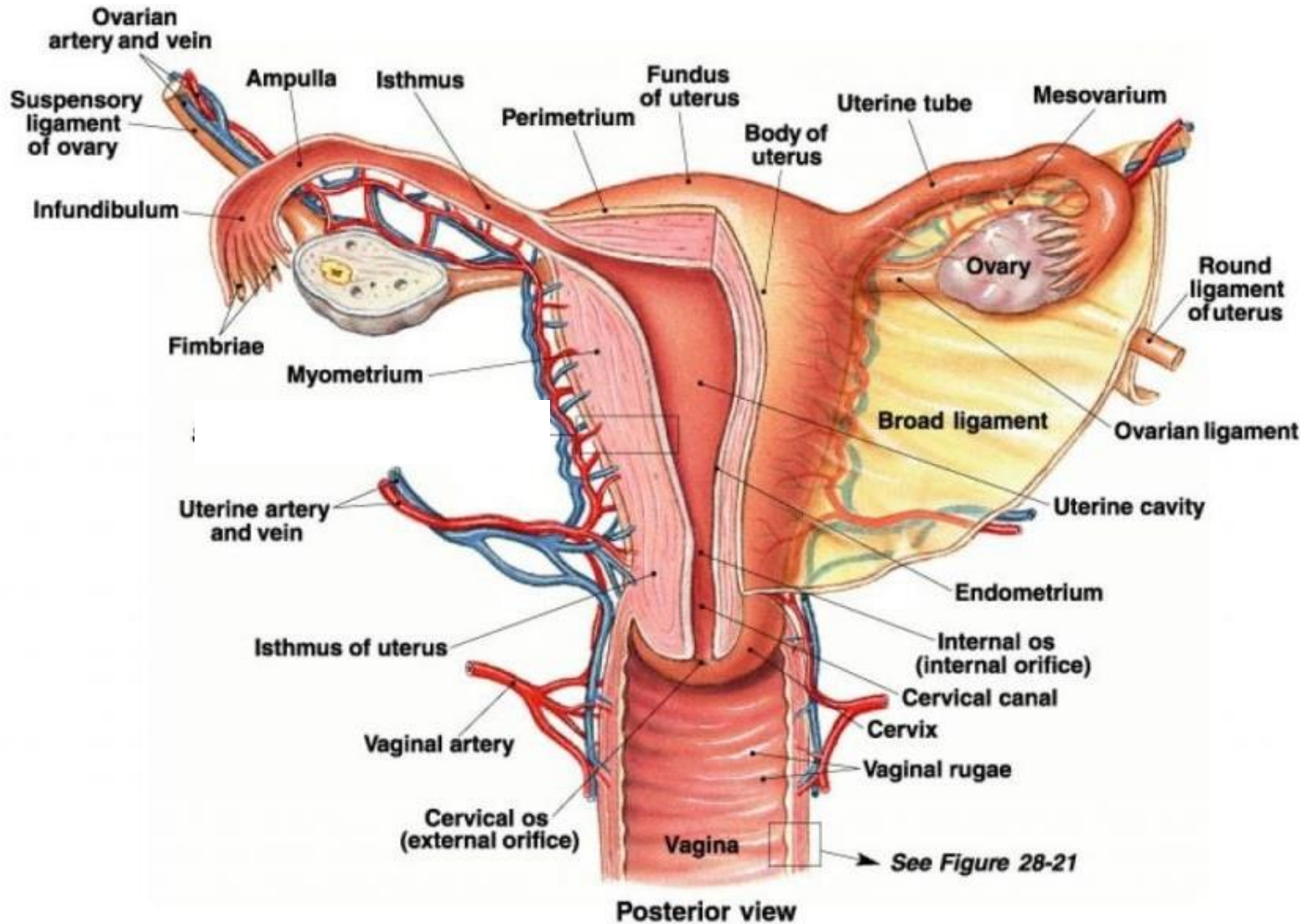
- **OBJECTIVES:**

- ↳ Discuss the anatomy of the female reproductive system.
- ↳ Describe the process of oogenesis.
- ↳ Discuss hormonal control of the female reproductive system and the functions of estrogen and progesterone.

Female Reproductive system

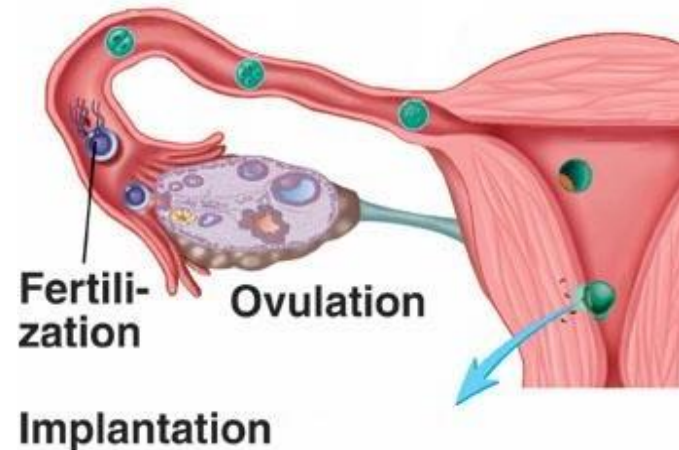
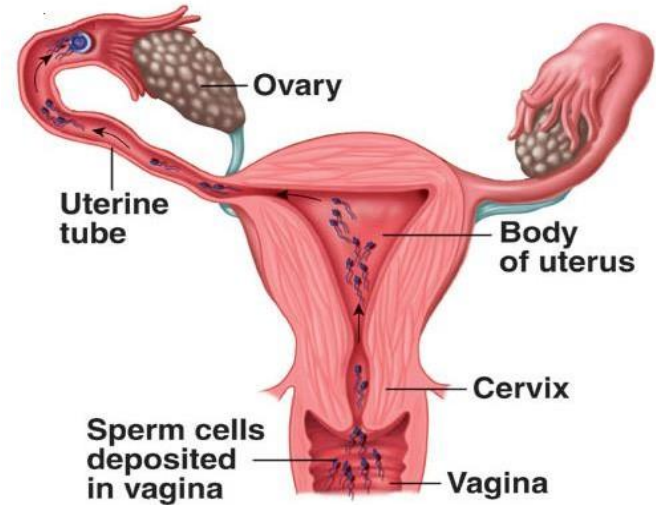


Female Reproductive system



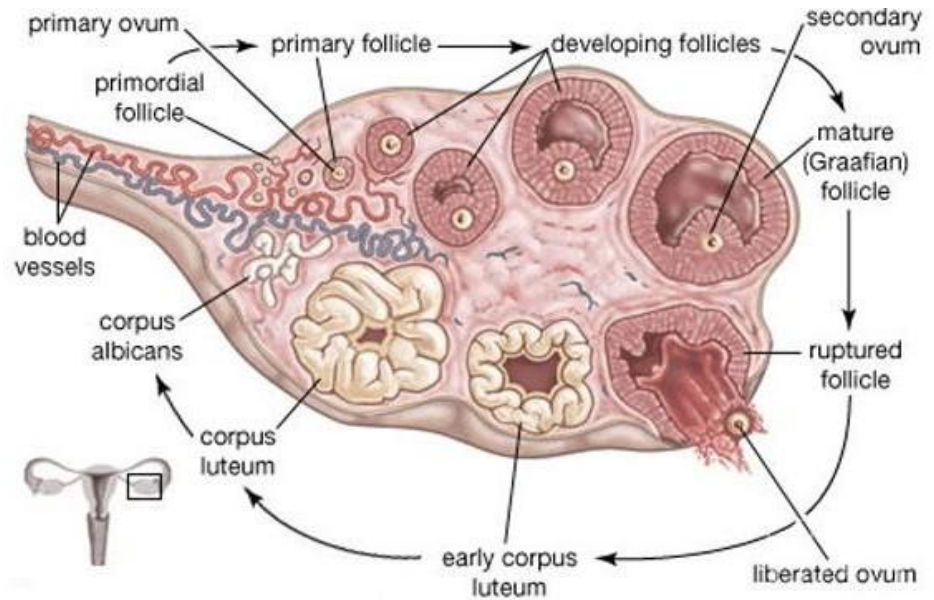
FEMALE REPRODUCTIVE SYSTEM

- Produces Ova.
- Accepts Sperms.
- Controls the process of Fertilization.
- Provides a site for Implantation.
- Provides essentials for Fetal Development to Term.



OOGENESIS

- Development of an ovum occurs in the ovary.
- Starts and stops during prenatal period.
- Resumes at puberty.
- Ends at menopause.
- Between puberty and menopause, oogenesis occurs on a regular basis as part of ovarian cycle.



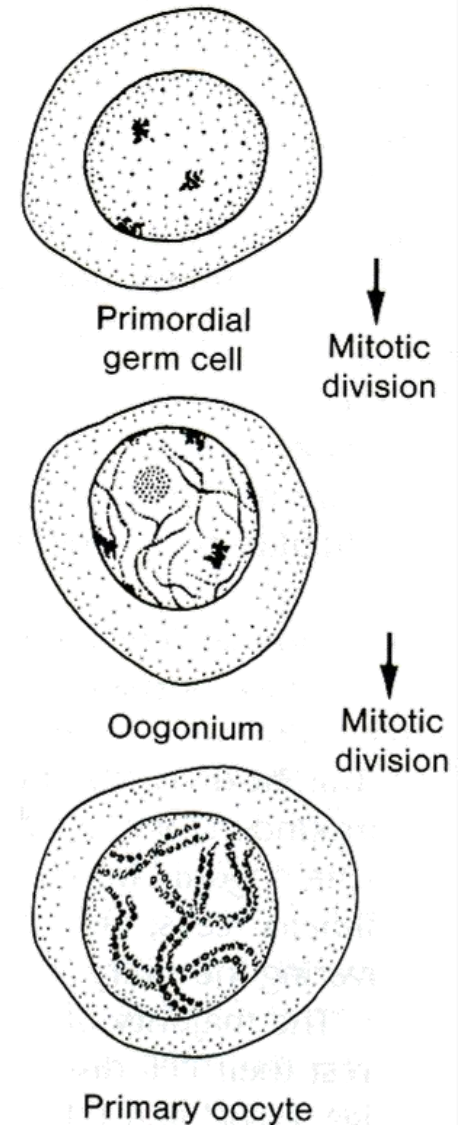
PRENATAL MATURATION OF OOCYTES

- **8 -10th Week:**

↪ 600,000 Oogonia

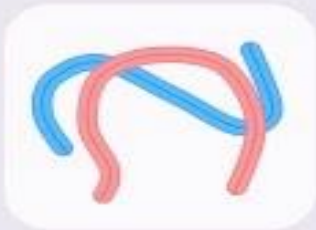
- **12th Week :**

↪ Oogonia begin differentiation into Primary Oocytes, enter prophase of 1st meiotic division.



PROPHASE stages:

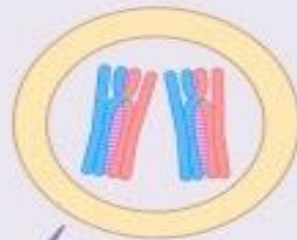
LEPTOTENE → ZYGOTENE → PACHYTENE → DIPLTENE → DIAKINESIS



Prophase begins
Chromosomes
start to condense



Synapsis begins
Synaptonemal
complex forms



Crossing over
DNA exchanged by
non-sister chromatids



Synapsis ends
Chiasma visible
within bivalent



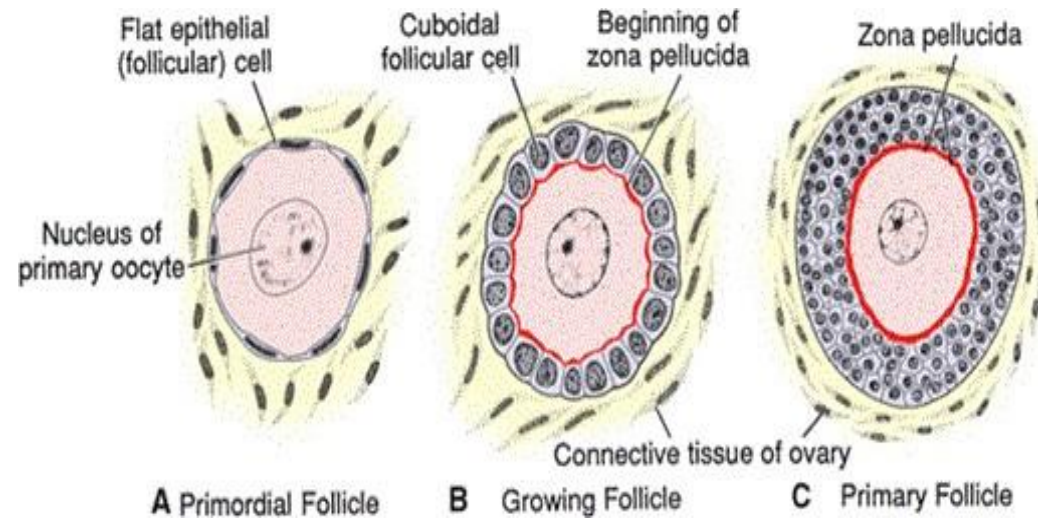
Prophase ends
Nuclear membrane
disintegrates

PRENATAL MATURATION OF OOCYTES

- **4th I.U Month:**



Primary Oocytes are surrounded by flat epithelial Follicular Cells.



- **5th I.U Month:**



Maximum number, 7,000,000 Primary Oocytes.

PRENATAL MATURATION OF OOCYTES

- **Subsequent Before Birth:**

 - ↪ Widespread degeneration

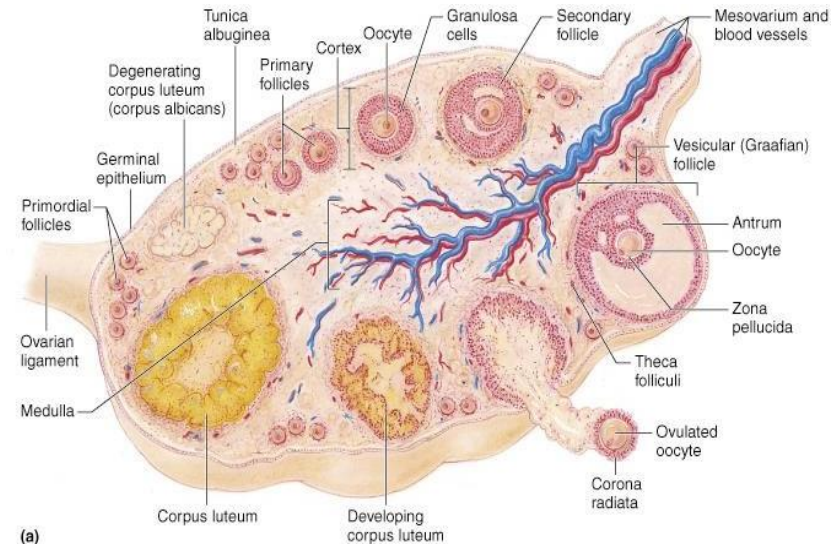
- **7th I.U Month:**

 - ↪ Majority of oocytes have degenerated except those in cortical region.

 - ↪ All surviving have entered into ~~the~~ meiotic division.

 - ↪ Completion of prophase does not occur until puberty/adolescence (11 to 19 years of age).

 - ↪ Follicular cells surrounding the primary oocyte are believed to secrete a substance, **Oocyte Maturation Inhibitor (OMI)**, which keeps the meiotic process of the oocyte arrested.



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PRENATAL MATURATION OF OOCYTES

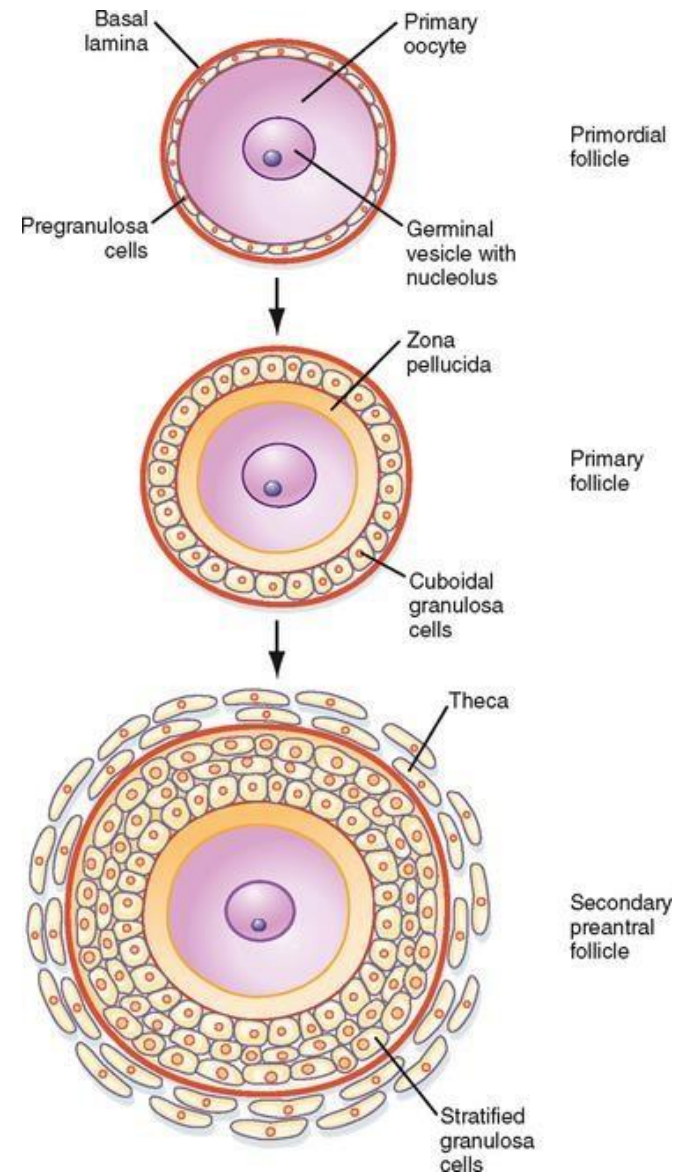
- **PRIMORDIAL FOLLICLE:**

↪ A Primary Oocyte together with its single layer of flat epithelial (follicular) cells.

- **NOTE:**

↪ Degeneration is a normal, common event in many parts of the human female reproductive system.

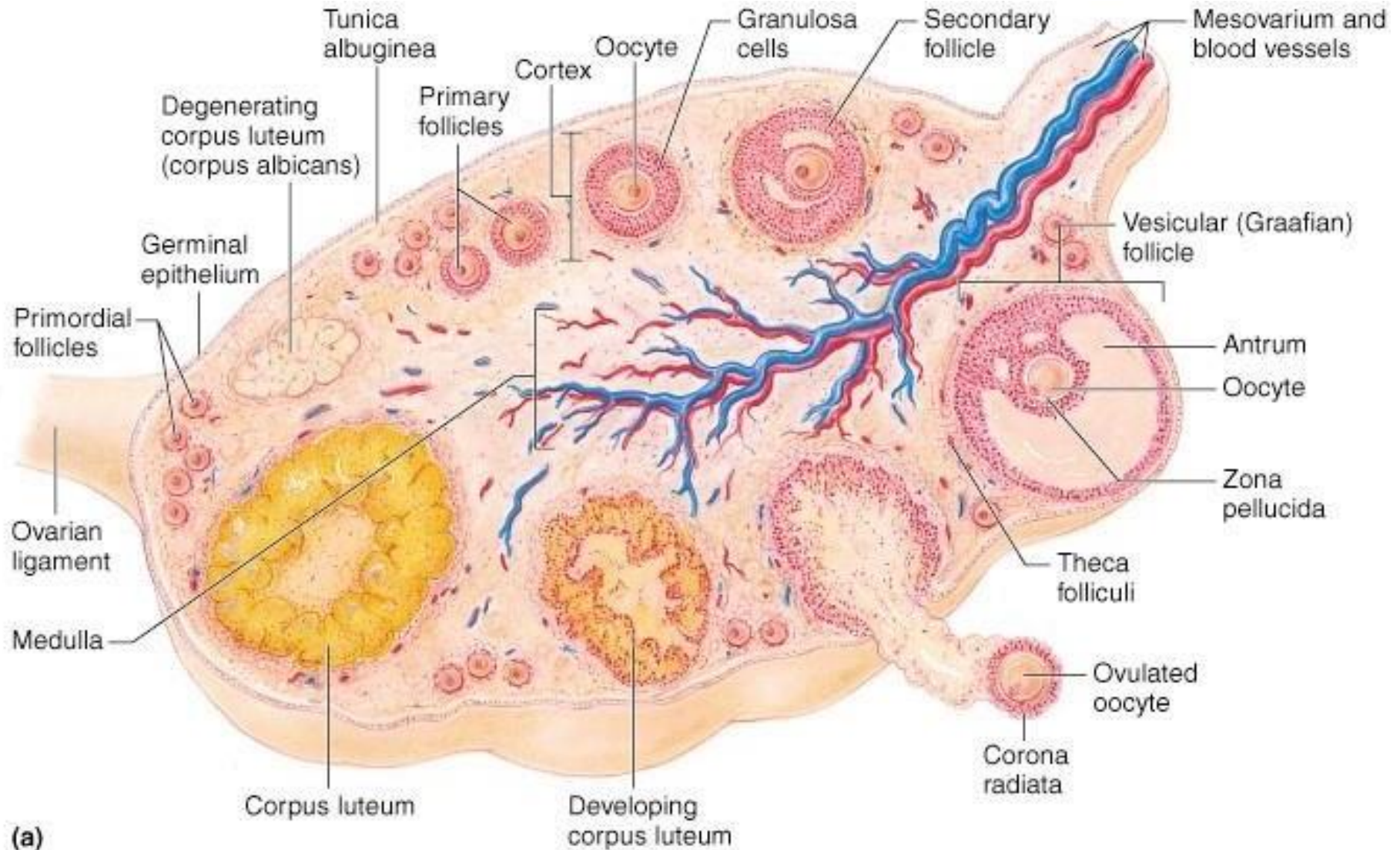
↪ Degeneration in germ cells development is characteristic of all mammals.



POSTNATAL MATURATION OF OOCYTE

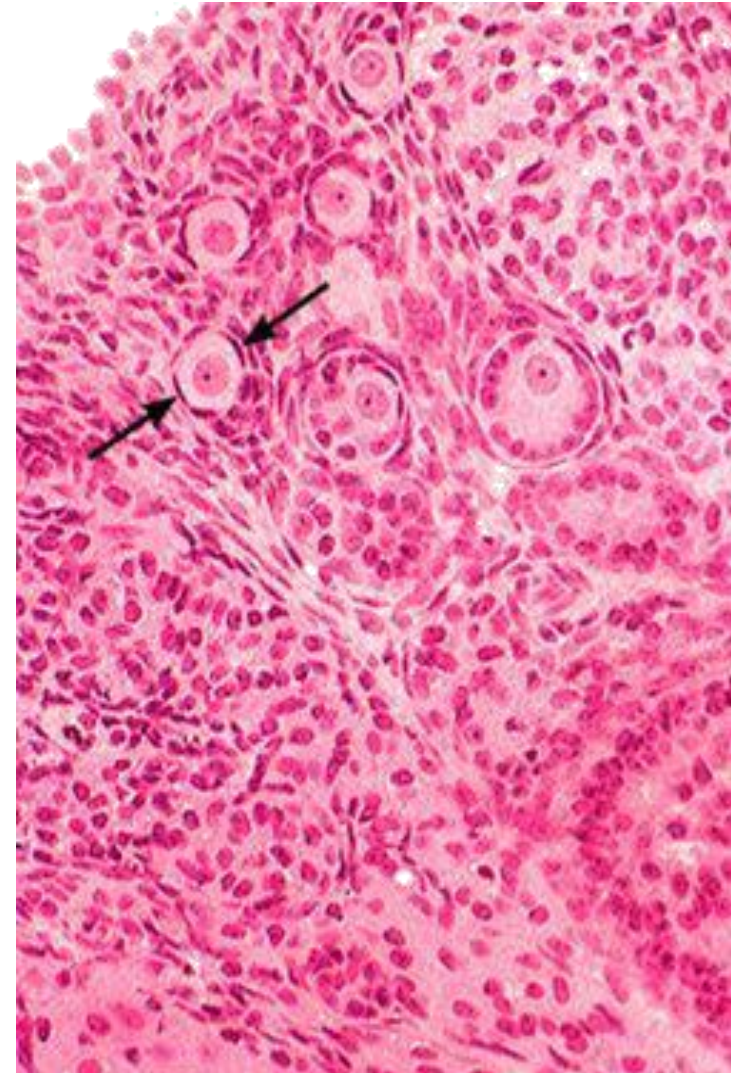
- At Birth 700,000 to 2 million.
- After Birth Further degeneration, which continues.
- At Puberty 40,000.
- Of These 400 – 500 are ovulated.
- Each Primary Oocyte (arrested prophase(diplotene) of 1st meiotic div)⇒⇒ (just before ovulation)(completes 1st meiotic div, becomes secondary oocyte and is again arrested & doesn't get into 2nd meiotic div, unless a sperm fertilizes it)
⇒ Mature Ovum (at fertilization)

Ovary Anatomy



POSTNATAL MATURATION OF OOCYTE

- **PRIMORDIAL FOLLICLES:**
 - ↪ Smallest follicle found in the ovaries after birth.
 - ↪ Consists of a **Primary Oocyte** (in arrested prophase of meiosis1) surrounded by a single layer of **squamous (flat) epithelial (follicular) cells**. Follicular cells secrete a substance **OMI (oocyte maturation inhibitor)**.
 - ↪ Basal lamina (Membrana Granulosa) of granulosa cells defines the outer boundary of the follicle.



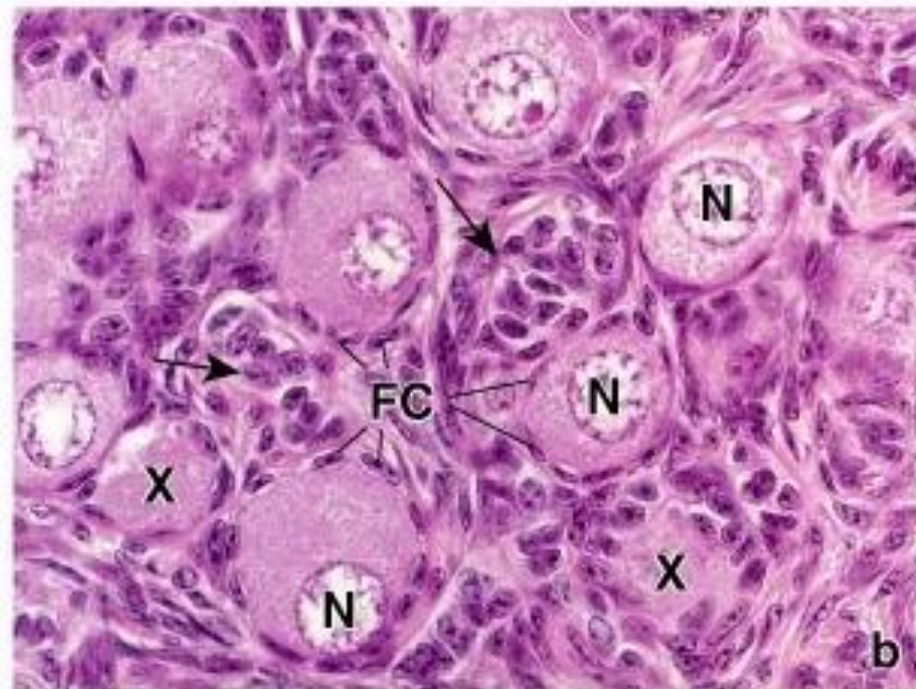
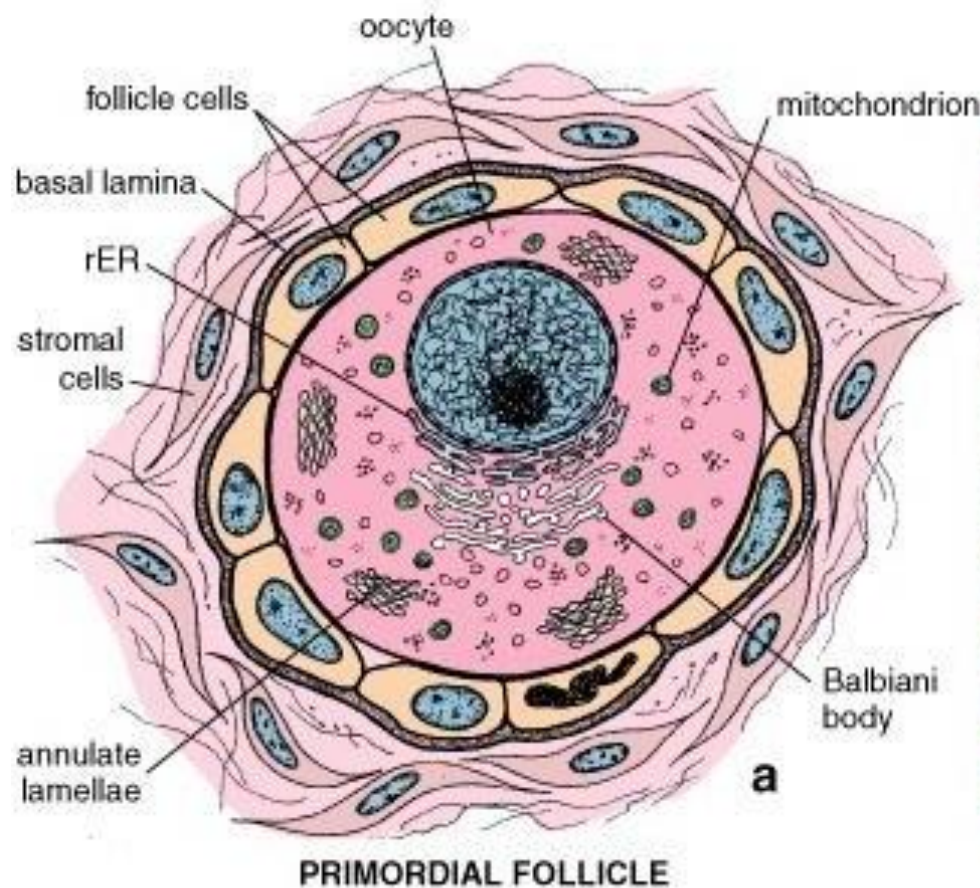
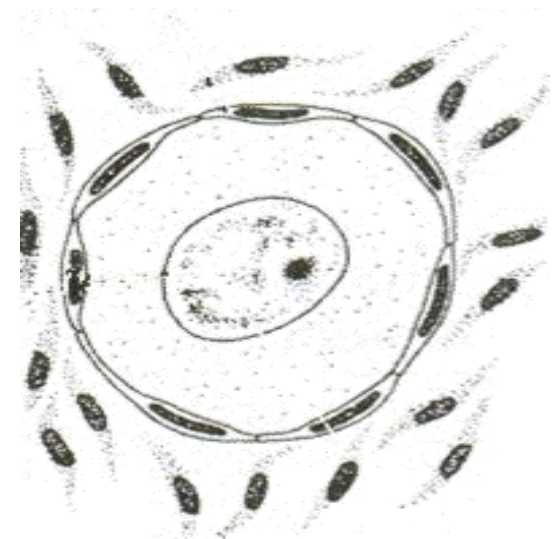
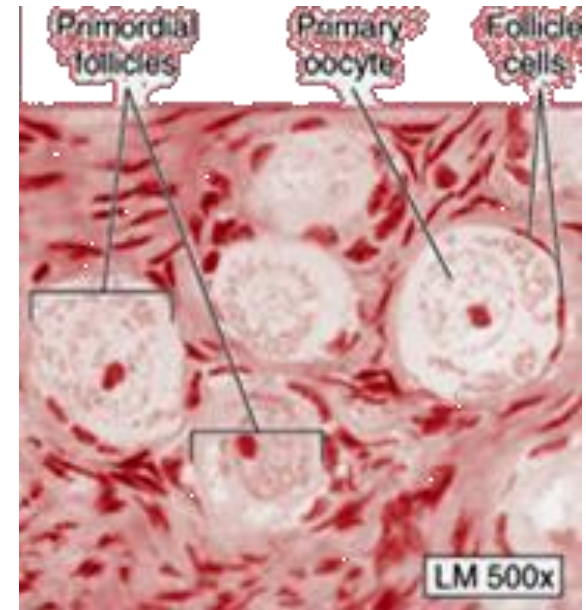


Figure 22.3. **Diagram and photomicrograph (X640) of a primordial follicle.** *FC*, follicle cells; *N*, nucleus; *X*, two oocytes in which the nucleus is not included in the plane of section; *arrows*, two follicles in which the follicle cells are revealed in face or tangential view and the enclosed oocyte is not.

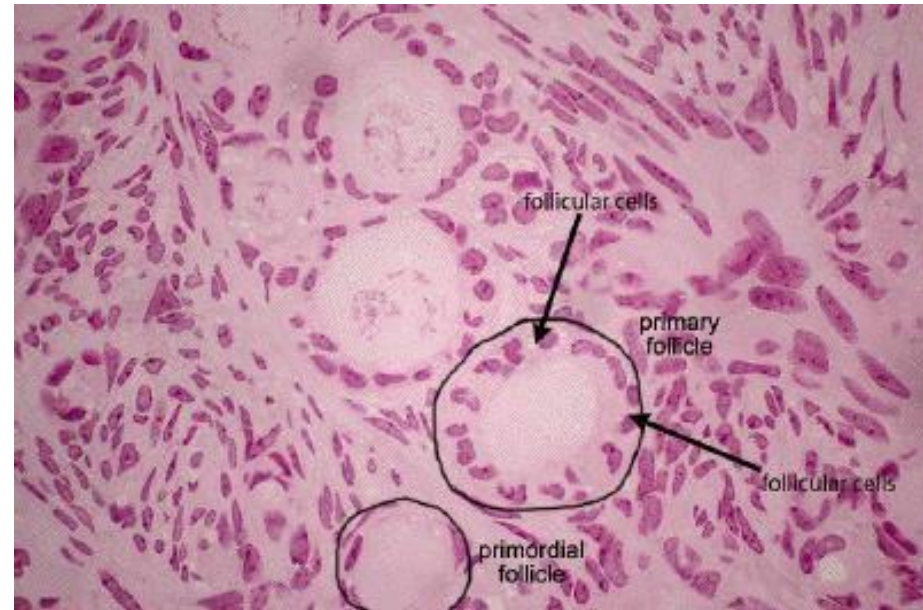
POSTNATAL MATURATION OF OOCYTE

- **PRIMORDIAL FOLLICLES:**
cont' d
- Prenatally the Oocytes proceed through the early prophase stages of meiosis I, and enter diplotene stage. Instead of condensing further and entering metaphase, the duplicated chromosomes extend and nucleoli reappear.
- The nucleus will remain arrested until puberty (ovulation).



POSTNATAL MATURATION OF OOCYTE

- Onset of sexual maturity – the ovary and uterus undergo monthly cyclical changes.
- At the commencement of each cycle a crop of Primordial Follicles leaves the arrested pool, begins the process of maturation and develops into **PRIMARY FOLLICLES**.
- As a rule, only one follicle matures; the remainder follicles undergo atrophy after a variable period of growth.



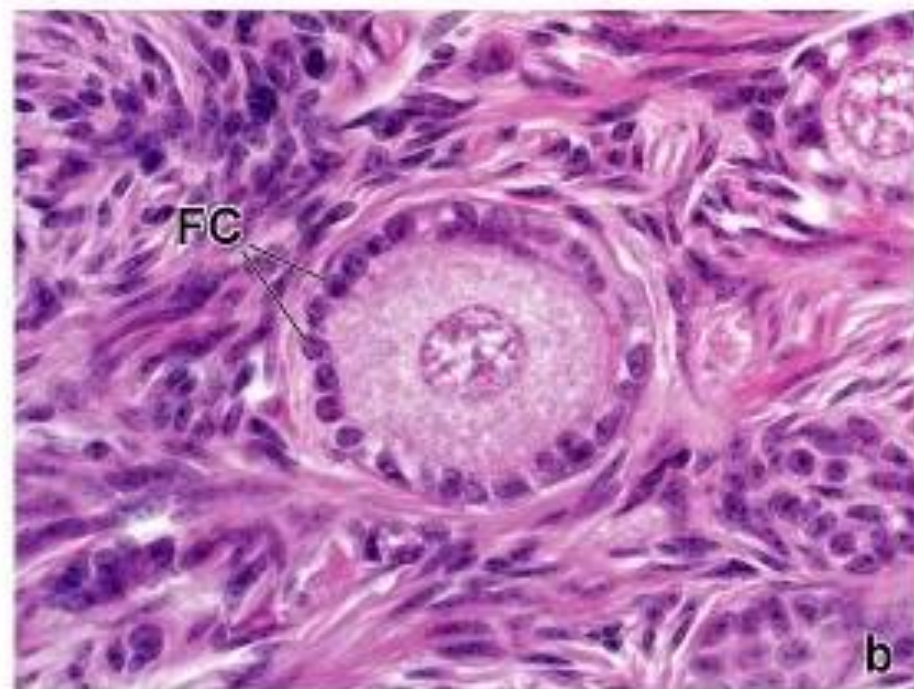
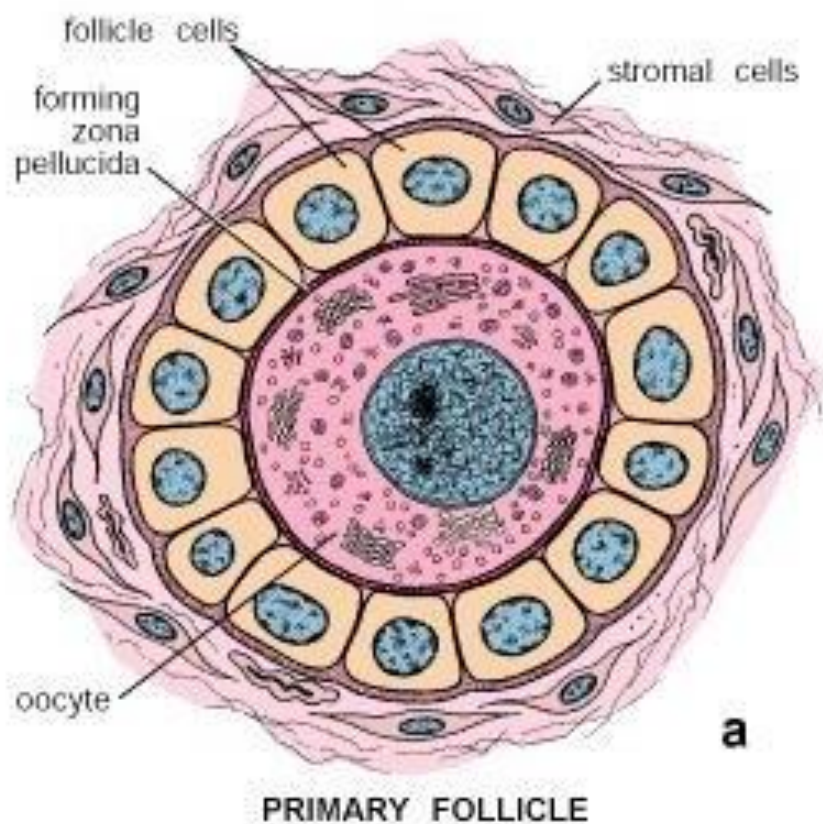


Figure 22.4. Diagram and photomicrograph (X 640) of an early primary follicle. *FC*, follicle cells.

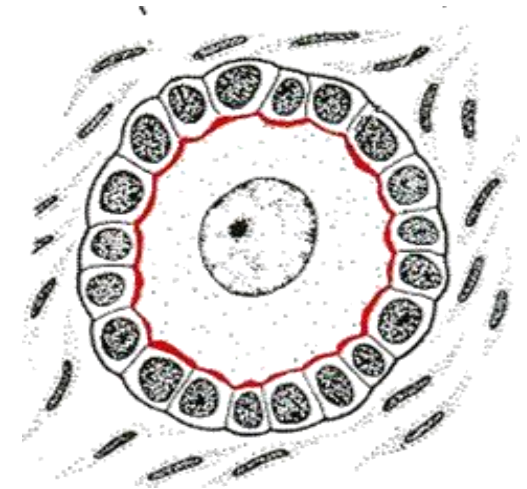
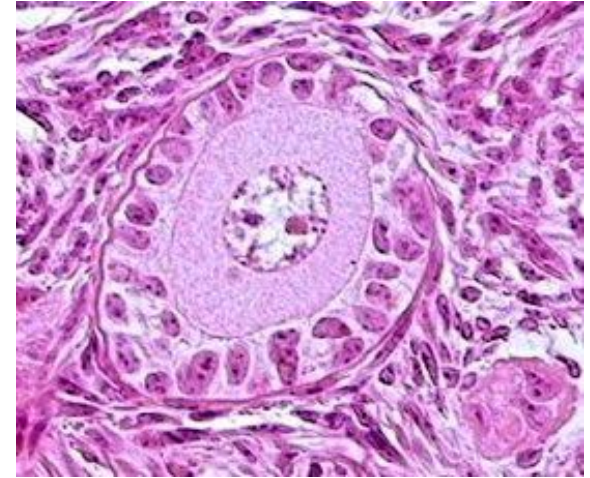
POSTNATAL MATURATION OF OOCYTE

- **EARLY (UNILAMINAR) PRIMARY FOLLICLE:**

↪ Single cuboidal shaped **granulosa/ epithelial/ follicular cell layer.**

↪ Oocytes complete most of their growth during this stage and the diameter of the oocyte may reach up to 117 – 142 μm .

↪ Granulosa cells acquire more organelles and molecules for synthetic activities.



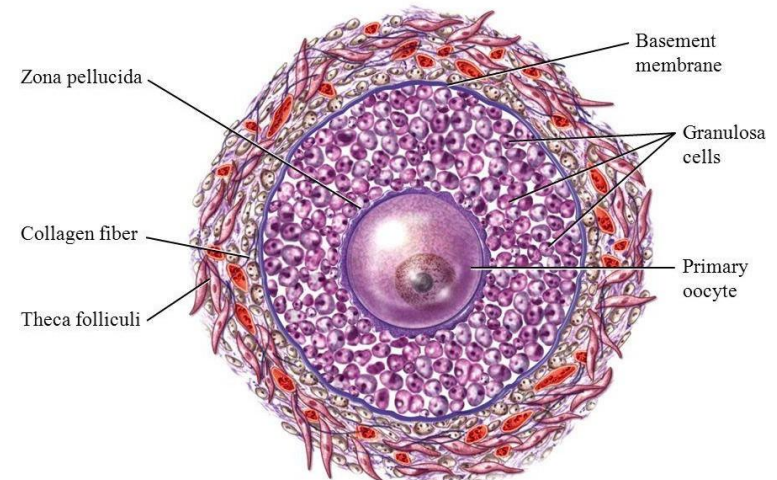
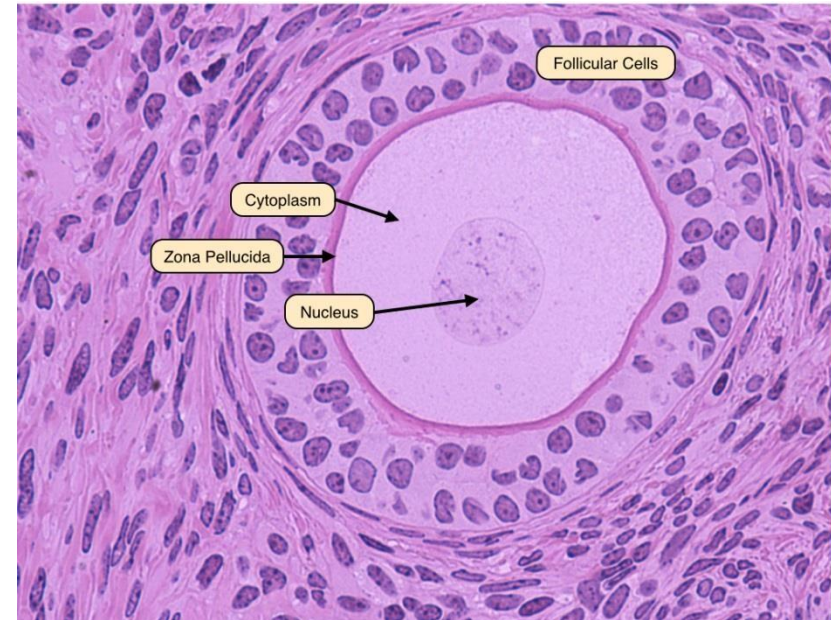
POSTNATAL MATURATION OF OOCYTE

- **LATE (MULTILAMINAR) PRIMARY FOLLICLE:**

↪ Granulosa(epithelial) cells multiply, become 5 – 6 cell layer thick.

↪ Synthesis of **ZONA PELLUCIDA**(non-cellular glycoprotein membrane).

↪ **As the follicle matures, a new cell layer, THECA FOLLICULI** around the primary follicle is in the process of being defined. Derived from ovarian stroma(connective tissue).



(b) Late primary follicle

THECA FOLLICULI

THECA INTERNA :

MORE CELLULAR, MORE VASCULAR,
SYNTHESIZE ESTROGEN.

THECA EXTERNA:

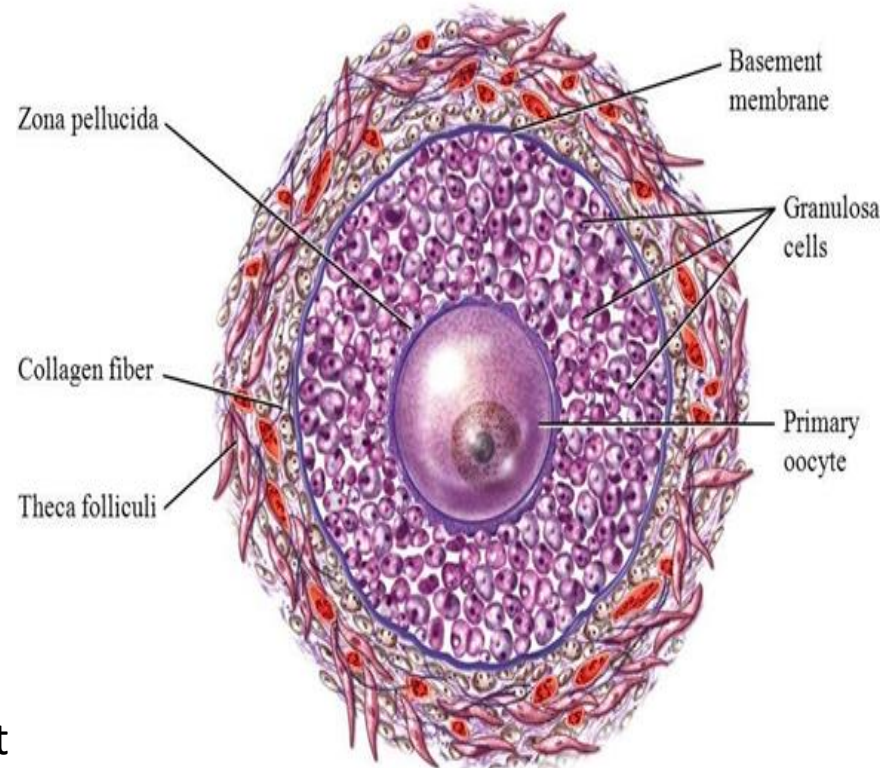
MORE FIBROUS, LESS CELLULAR, LESS
VASCULAR.

Maturation of follicles require FSH. The
granulosa/ epithelial/follicular cells start with
having receptors for FSH.

The THECA INTERNA start expressing LH
receptors.

THECA INTERNA cells produce **testosterone** that
penetrates granulosa epithelial cells.

AROMATASE enzyme in granulosa ep cells
coverts it into **17-beta-estradiol**. And then goes
back to theca interna & blood vessels of TI
circulate it in the female body to perform
different functions.

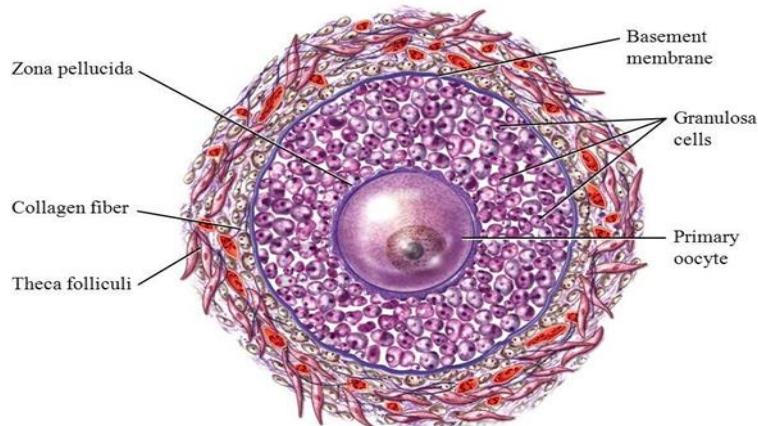
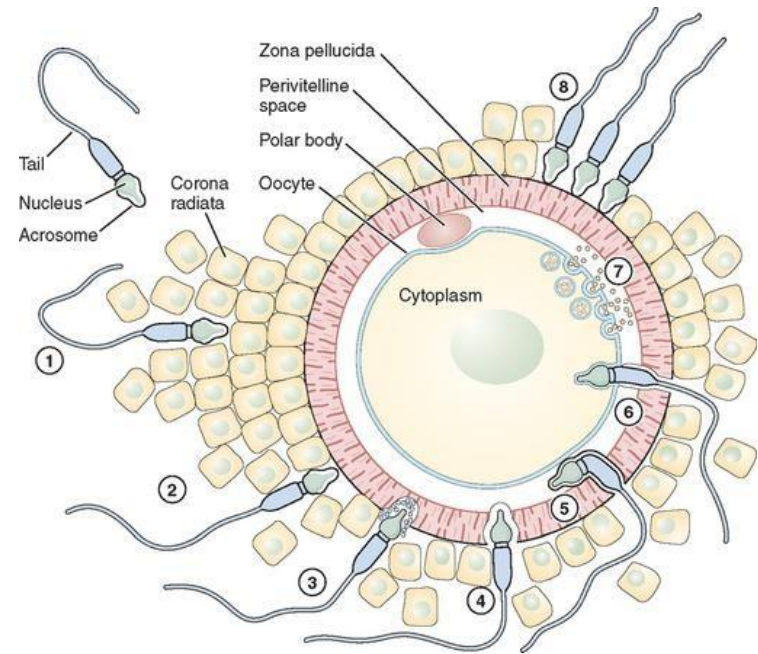


(b) Late primary follicle

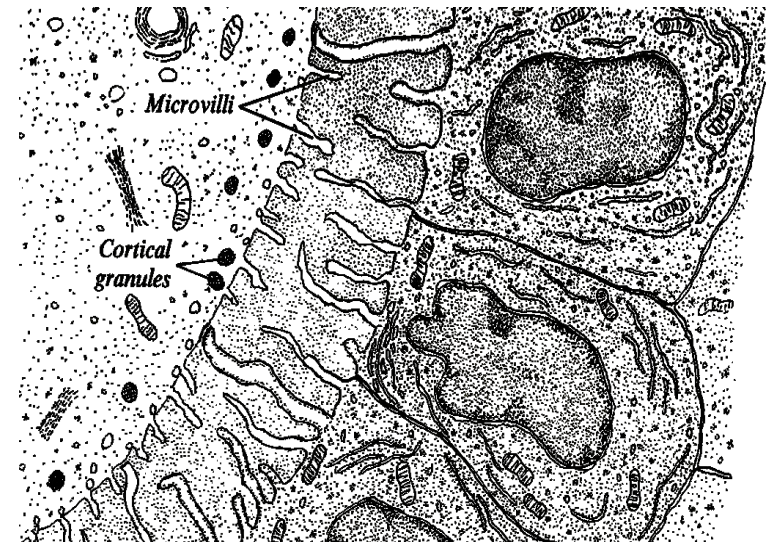
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ZONA PELLUCIDA

- As the primary follicle takes shape, a thick, prominent, translucent, non cellular, radially striated, PAS +ive, glycoprotein membrane forms between the primary oocyte and its enveloping follicular cells.
- The microvillous connections between the oocyte and follicular cells are maintained through the zona pellucida.
- **SOURCE:** secreted by follicular cells as well as primary oocyte.

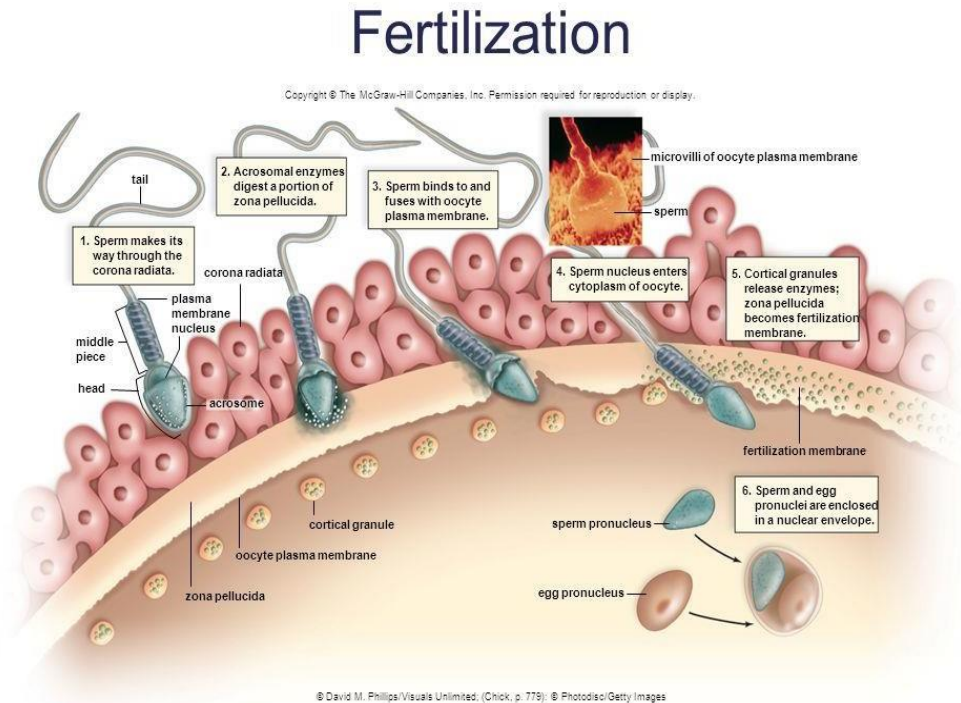


(b) Late primary follicle



ZONA PELLUCIDA

- Z.P is slowly lysed in alkaline medium, degraded by Acrosomase.
- Main role appears to be at fertilization - responsible for **species specific recognition of spermatozoa** and also for triggering acrosome reaction.
- After fertilization, block to polyspermy.
- It prevents the blastomeres of early cleaving embryo from dissociating.
- Semipermeable membrane (substances reach blastocyst from the uterine tube).
- Immunological barrier. Lacks IHC antigens.
- Prevents premature implantation of cleaving embryo into the wall of uterine tube.



POSTNATAL MATURATION OF OOCYTE

- **THECA FOLLICULI:**

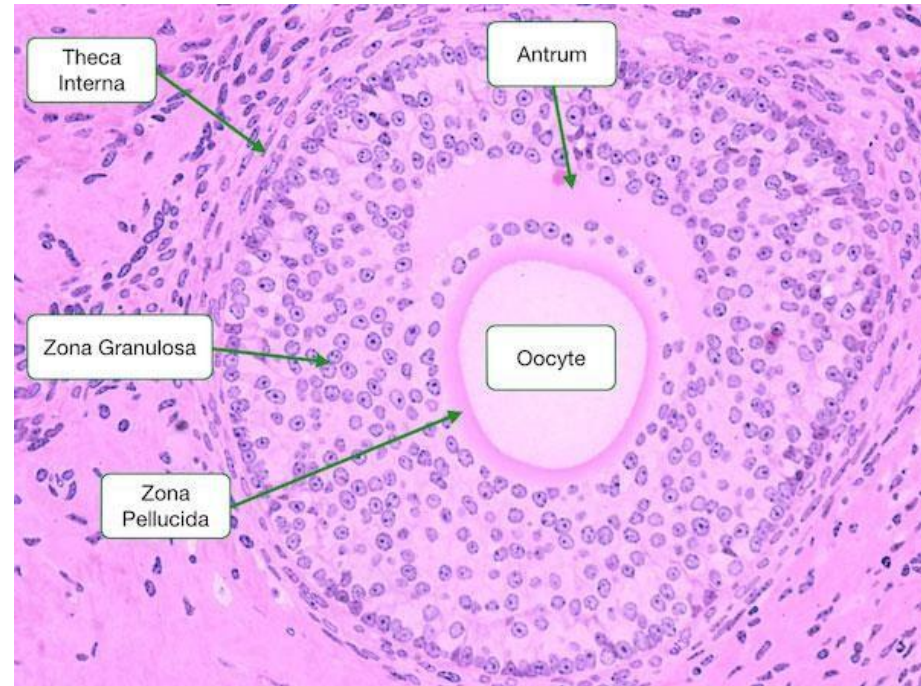
↪ As follicle matures, a new layer of cells, **THECAL CELLS** form around the follicle, secrete **angiogenesis factor**.

↪ Thecal cells are derived from ovarian stroma.

↪ **Differentiate into two layers:**

➤ **Theca Interna:** more cellular and highly vascular.

➤ **Theca Externa:** more C.T like

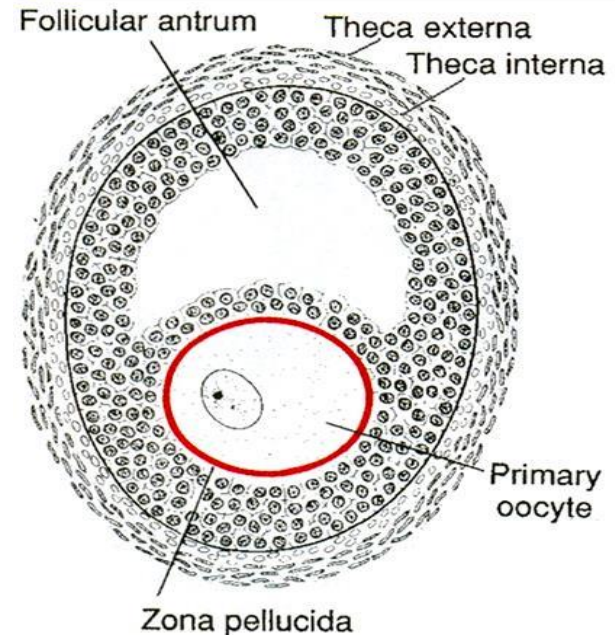
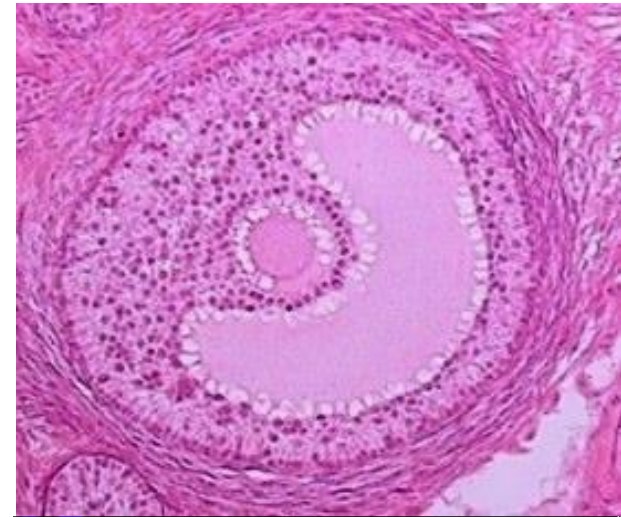


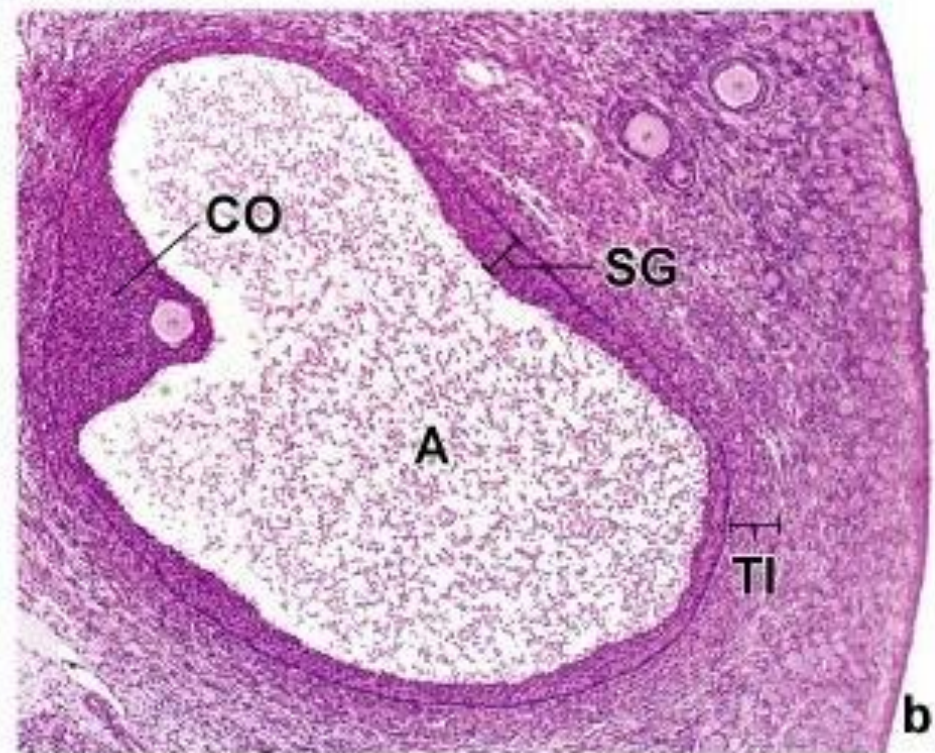
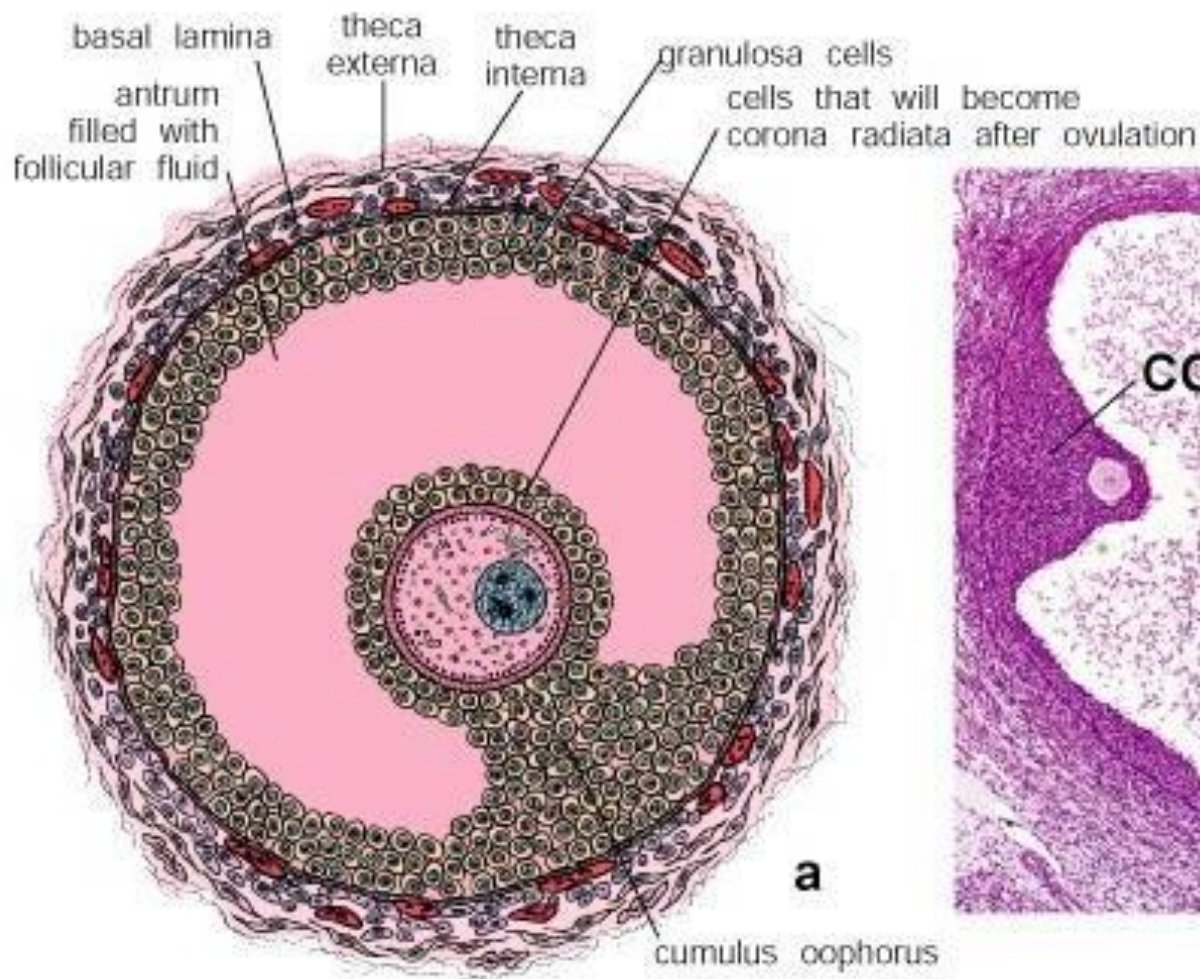
POSTNATAL MATURATION OF OOCYTE

- **SECONDARY FOLLICLE:**

↪ Formation of a cavity (**Antrum**) in granulosa cells converts Primary Follicle in to Secondary Follicle.

↪ **LIQUOR FOLLICULI:** ~~is~~ formed by follicular cells, later mostly as a transudate.





MATURE GRAAFIAN FOLLICLE

Figure 22.7. Diagram and photomicrograph (X45) of a secondary follicle in a late stage of development. A, antrum; CO, cumulus oophorus; MG, membrana granulosa.

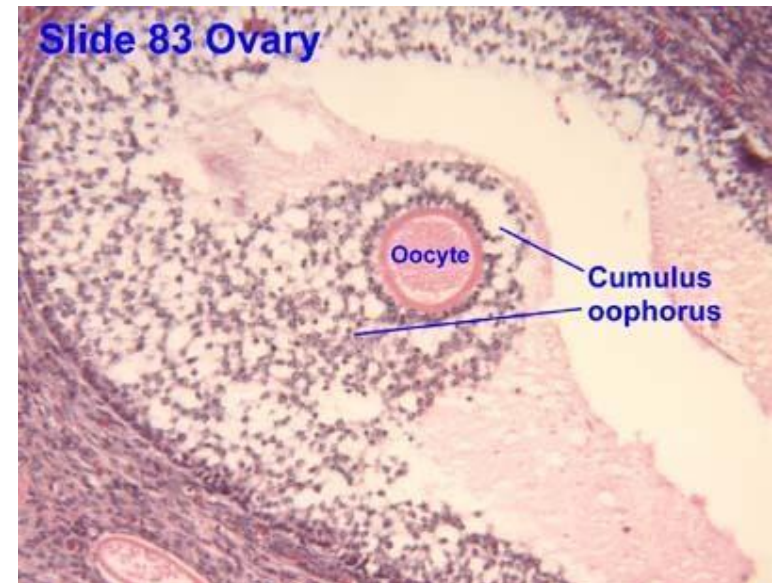
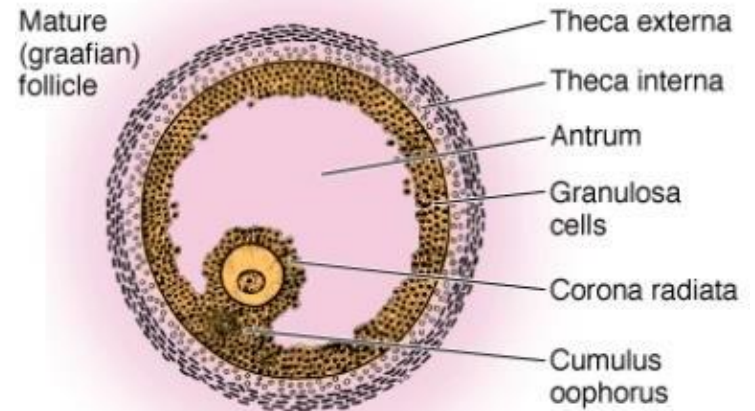
POSTNATAL MATURATION OF OOCYTE

- **TERTIARY (GRAAFIAN) FOLLICLE:**

↳ Under multiple hormonal influences, the follicle enlarges rapidly.

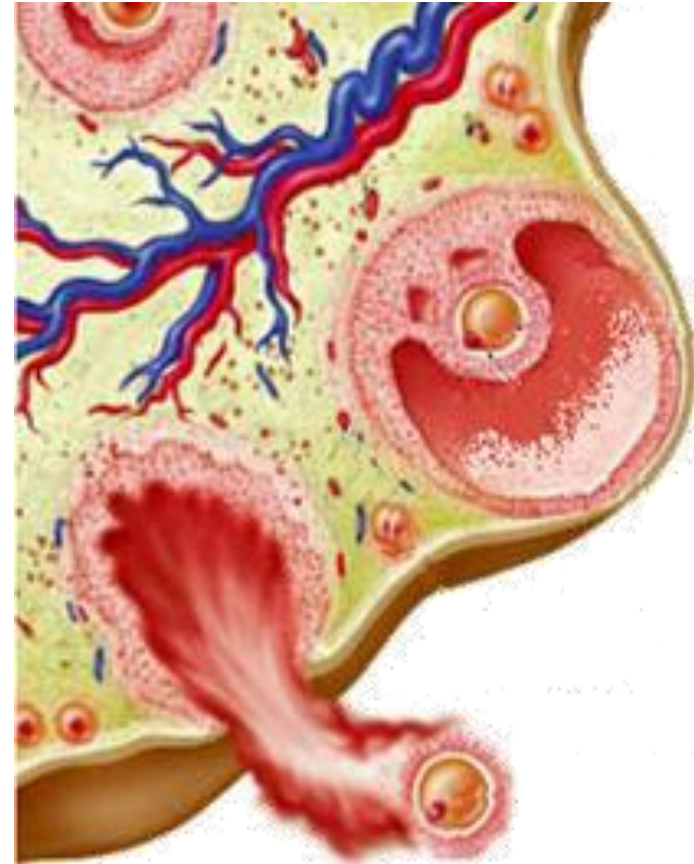
↳ The **Primary Oocyte**, is located in a small mound of cells – the **CUMULUS OOPHORUS**, lying on one side of the greatly enlarged antrum.

↳ The diameter of the follicle increases from 6mm early 2nd week to 2 cm at ovulation.



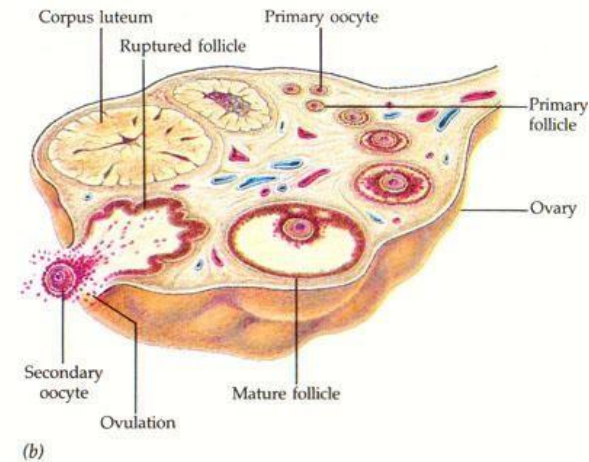
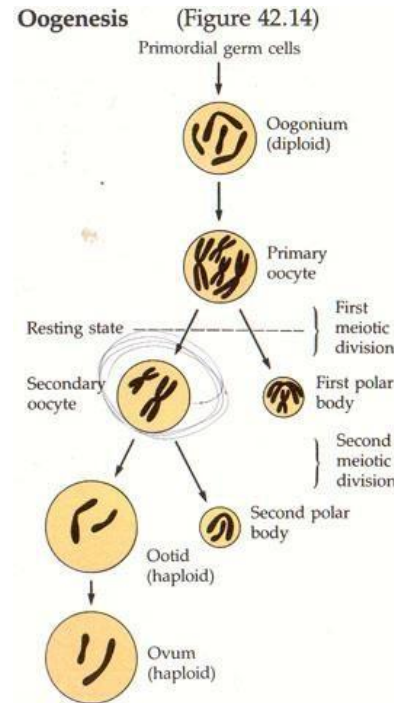
POSTNATAL MATURATION OF OOCYTE

- Press against the surface of ovary, protrude from the surface like a blister, the Stigma. This happens at the middle of the menstrual cycle (~ day 14)
- The follicular fluid contains:
 - ↪ Enzymes (about 20).
 - ↪ FSH, Steroid hormones.
 - ↪ Proteoglycans (-ive ly charged – attract water molecules).
 - ↪ Proteins similar to serum.
- TERTIARY FOLLICLE is now poised for ovulation and awaits the stimulus of the strong preovulatory surge of FSH & LH, which is itself caused by high estrogen.



POSTNATAL MATURATION OF OOCYTE

- **FSH & LH** surge stimulates the Primary Oocyte to resume meiosis ~ 10 – 12 hrs before ovulation.
- Cell division to form the **secondary oocyte and 1st Polar Body** rapidly occurs.
- Secondary Oocyte promptly begins the **2nd meiotic division** BUT,.....
- **3 hrs before ovulation**, is arrested at the metaphase of the 2nd meiotic division.



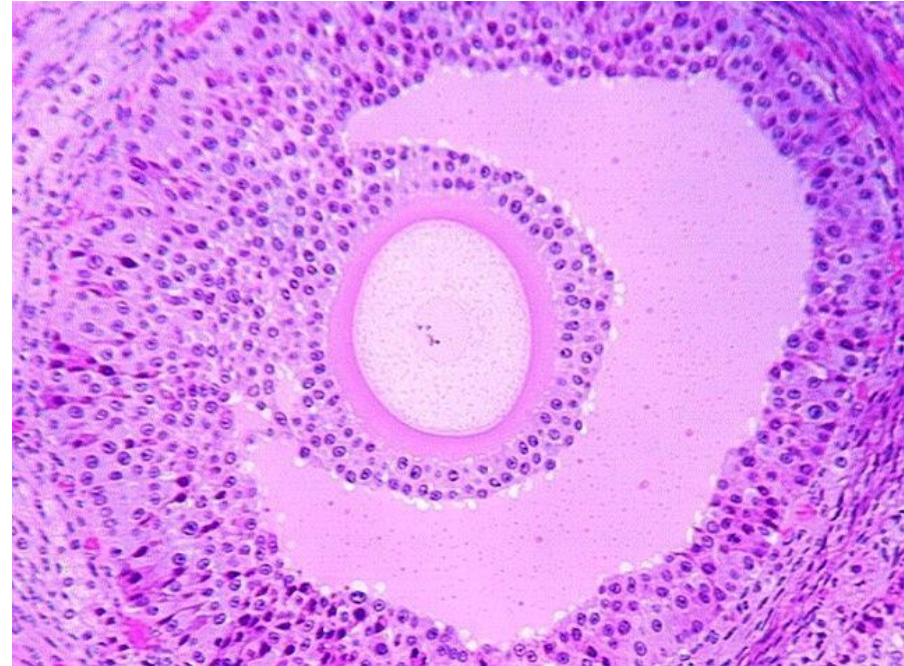
OVULATION

- In response to LH & FSH surge:

- ↳ Cumulus cells secrete abundant extra – cellular matrix, mainly hyaluronic acid, which causes the cumulus cell mass to expand several fold.

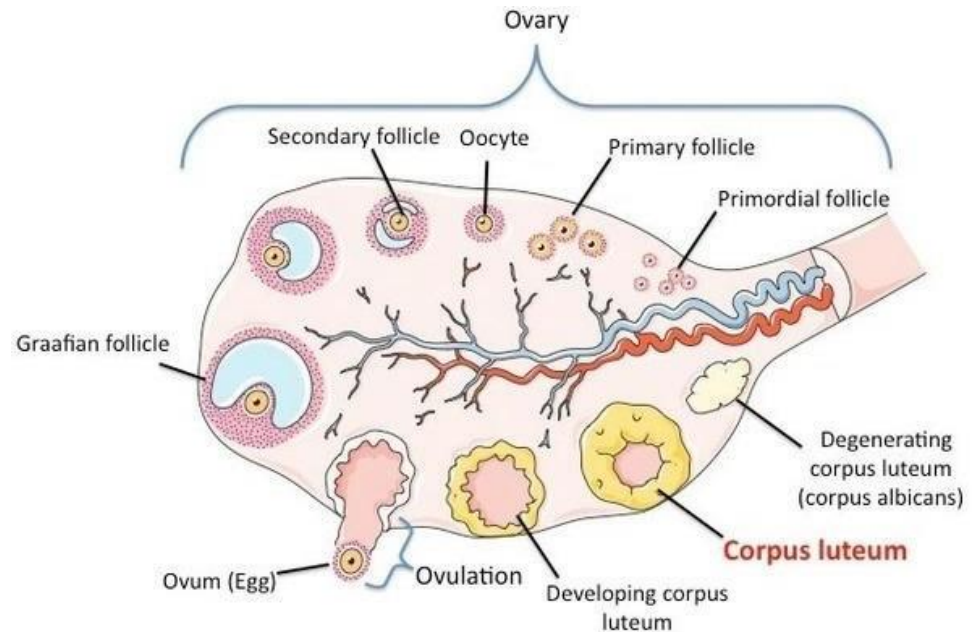
- ↳ Follicle becomes more vascularized, is visibly pink and edematous.

- ↳ Displaced to the surface of ovary.



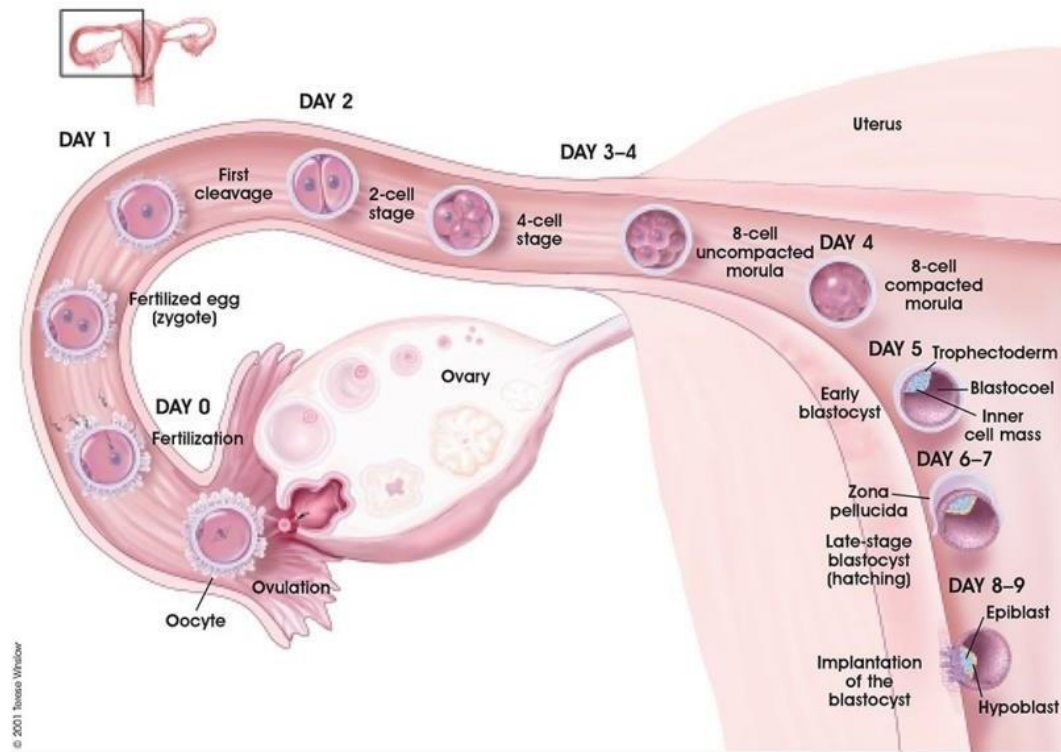
OVULATION

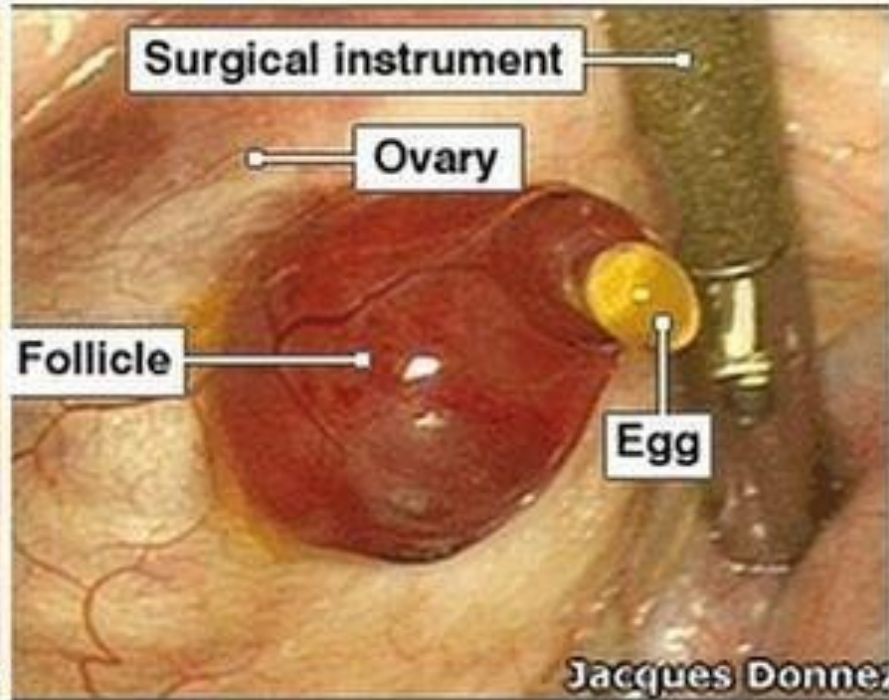
- Finally, intrafollicular pressure and thecal smooth muscle contraction plus the release of collagen – degrading enzymes cause the follicle to rupture.
- Oocyte is slowly extruded onto the surface of the ovary accompanied by large number of investing cumulus cells and some sticky follicular fluid.



OVULATION

- Once out, the **fimbriated mouth** of the uterine tube actively sweep the cumulus – oocyte complex into the **infundibulum** and then carries it to ampullary region.
- Oocyte may remain viable for as long as **24 hrs** before it loses its capacity to be fertilized.





Oogenesis (Figure 42.14)

Primordial germ cells



Oogonium (diploid)



Primary oocyte

Resting state

Secondary oocyte



First polar body



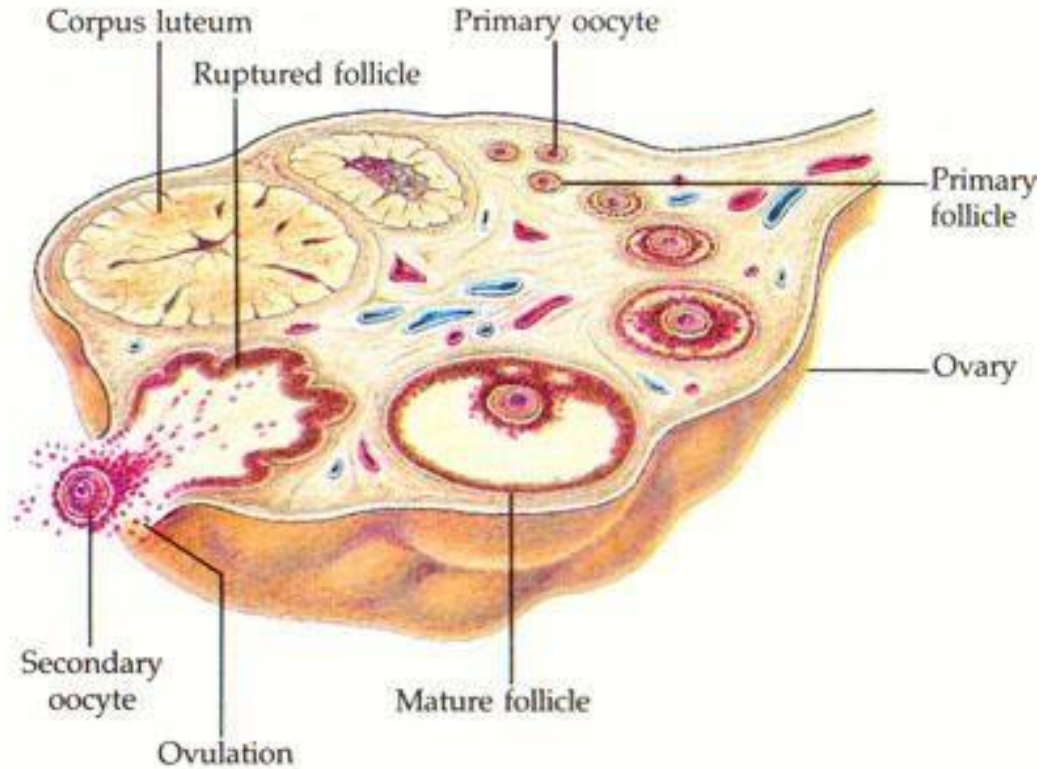
First meiotic division

Second meiotic division

Second polar body

Ootid (haploid)

Ovum (haploid)



(b)

“The most grateful to Allah are those who are most grateful to other people...”

جزا الله خيرا