

The female reproductive system

- The female reproductive system consists of two ovaries, two oviducts, the uterus, the vagina and the external genitalia. Its functions are to produce female gametes and to hold a fertilized oocyte during its development through embryonic and fetal stages until birth. The system also produces sexual hormones that control the reproductive system and influence other organs in the body.
- **Menarche** is the first menstrual cycle (average age ~12.7 years).
- **Menopause** is the gradual end of menstrual cycles (average age ~52.4 years).

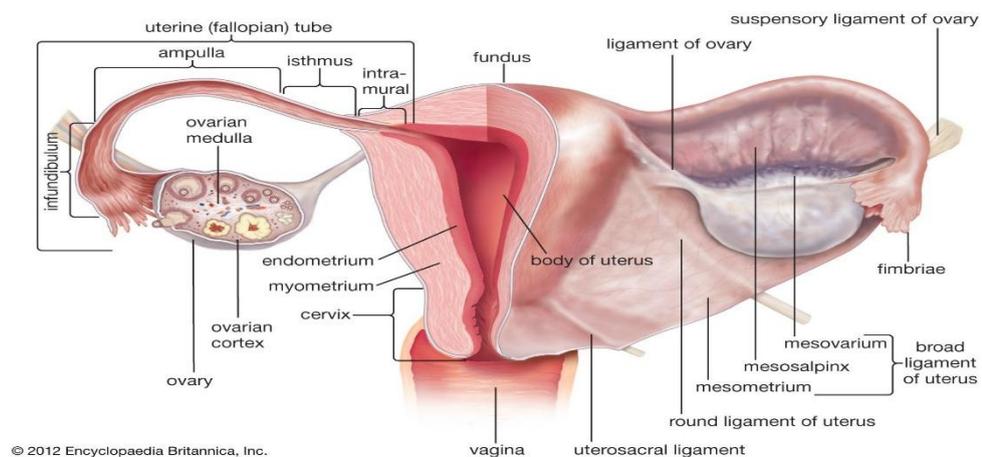


Figure 1. Internal organs of the female reproductive system.

Ovaries:

- Ovaries are almond-shaped organs (~3 × 1.5 × 1 cm).
- Covered by **germinal epithelium** (simple squamous/cuboidal); most ovarian tumors originate here (>70%).
- Beneath it lies the **tunica albuginea** (dense connective tissue).
- The **cortex** contains ovarian follicles within the stroma.



- The **medulla** is the inner region, rich in blood vessels and loose connective tissue.

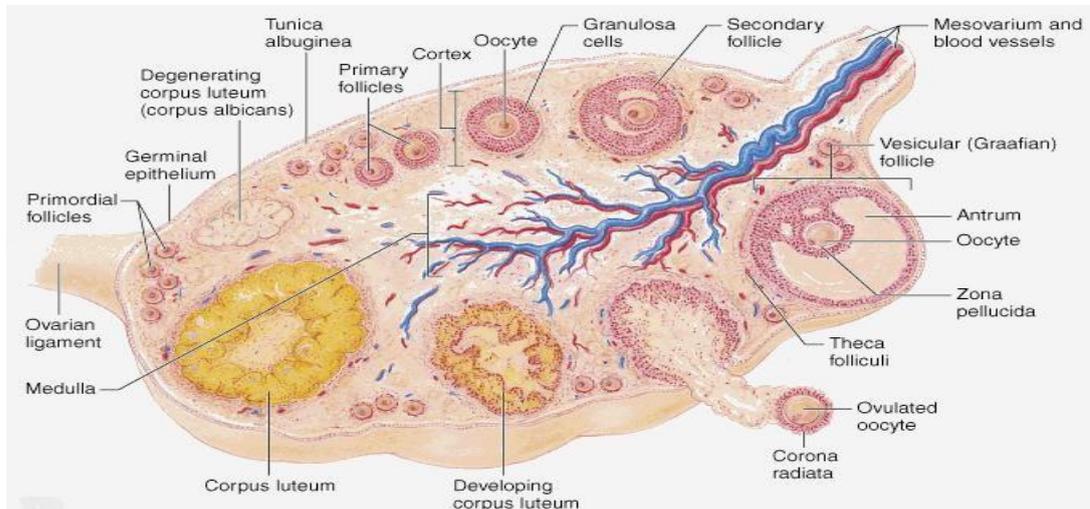


Figure 2. Ovary of a woman of reproductive age showing its main components: germinal epithelium, tunica albuginea, cortical, and medullary regions.

Ovarian follicles:

An ovarian follicle consists of an oocyte surrounded by one or more layers of follicular cells, or granulosa cells. A basal lamina marks the boundary between the follicle and the surrounding stroma. The follicles that are formed during fetal (**primordial follicles**) consist of primary oocyte enveloped by a single layer of flattened follicular cells. The oocytes present at birth remain arrested at first meiotic division.

Follicular growth:

- At puberty, small groups of primordial follicles begin **follicular growth** under the influence of FSH.
- Follicular cells proliferate:
 - **Unilaminar primary follicle** → single cuboidal layer
 - **Multilaminar (preantral) follicle** → multiple layers (granulosa cells)
- The **zona pellucida** forms around the oocyte; cell connections occur



Histology
2nd Class
Prof. Dr. Marwa Fadhil Alsaffar



via gap junctions.

- Fluid accumulation creates the **antrum**, forming a **secondary (antral) follicle**.
- Granulosa cells organize into:
 - **Cumulus oophorus** (supports oocyte)
 - **Corona radiata** (surrounds oocyte)
- Surrounding stroma forms:
 - **Theca interna** → produces androgens
 - **Theca externa** → supportive layer
- Granulosa cells convert androgens to **estrogen** (via aromatase).
- Usually, one follicle becomes a **mature (Graafian) follicle** and ovulates; others undergo **atresia**.



Histology

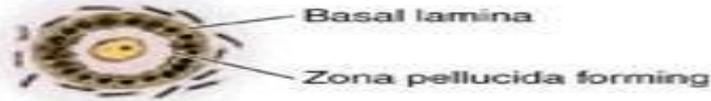
2nd Class
Prof. Dr. Marwa Fadhil Alsaffar



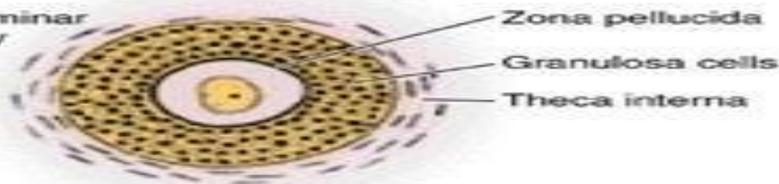
Primordial follicle



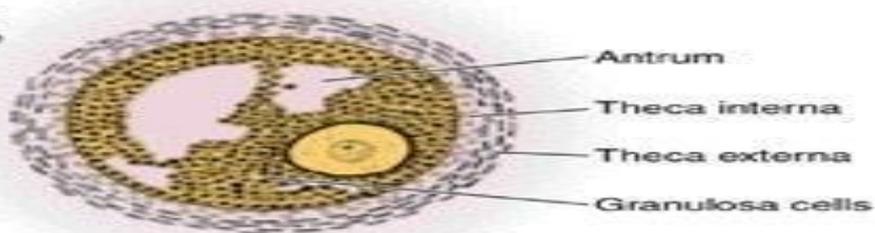
Unilaminar primary follicle



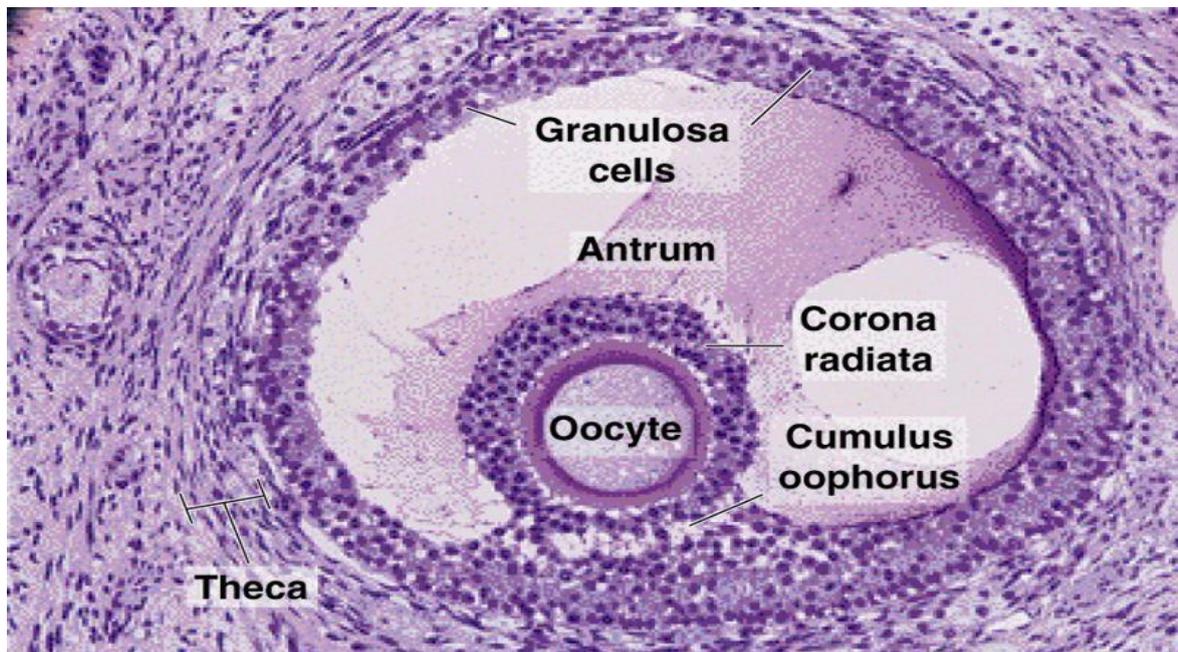
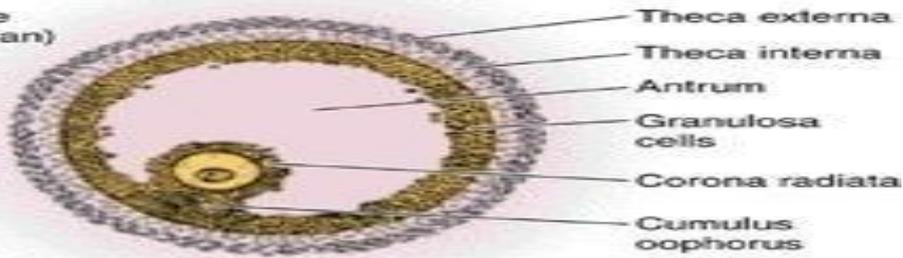
Multilaminar primary follicle



Antral follicle

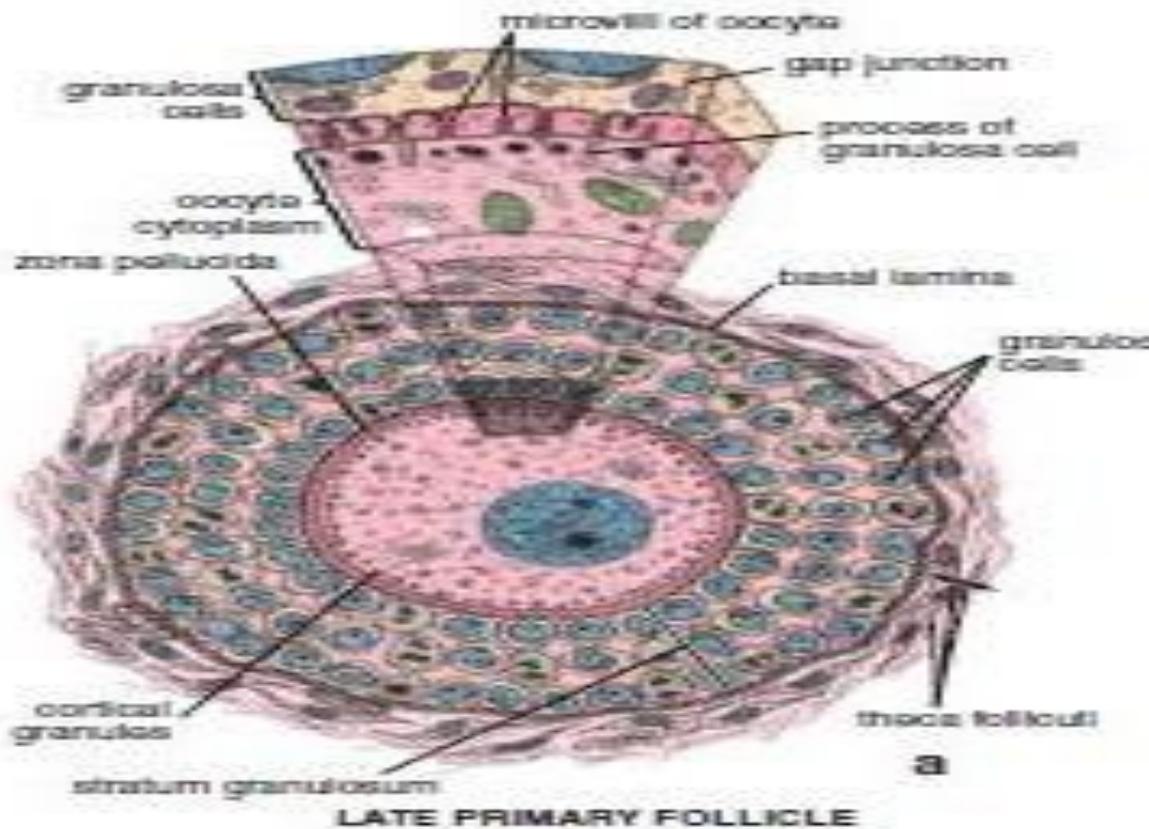


Mature (graafian) follicle





Mature Graafian follicle



Follicular atresia:

Most ovarian follicles undergo atresia in which follicular cells and oocytes die and are disposed of by phagocytic cells. Follicles at any stage of development may undergo atresia. This process is characterized by cessation of mitosis in the granulosa cells from the basal lamina and death of the oocyte and granulosa cells. At later stage, fibroblasts occupy the follicle and produce a scar of collagen that may persist for a long time. Follicular atresia takes place from before birth until a few years after menopause.

Ovulation:

- Ovulation is the release of the oocyte from the mature follicle.



Histology

2nd Class

Prof. Dr. Marwa Fadhil Alsaffar

- It usually occurs around day 14 of a 28-day cycle.
- Normally, one oocyte is released, but sometimes more → may lead to twins if fertilized.
- Ovulation is triggered by a surge of LH hormone, due to high estrogen levels.
- **Before ovulation:**
 - The follicle wall becomes weak (due to cell death and reduced blood flow).
 - Pressure from follicular fluid causes it to rupture.
 - A visible sign is the stigma (a pale spot on the follicle surface).
 - Just before ovulation:
 - The oocyte completes the first meiotic division → forms a secondary oocyte + polar body.
 - It then starts the second division and stops in metaphase.
- **After release:**
 - The oocyte (with zona pellucida and corona radiata) enters the uterine tube.
 - It can be fertilized within 24 hours, otherwise it degenerates.

Corpus Luteum:

After ovulation, granulosa and theca cells reorganize to form the **corpus luteum**, a temporary endocrine gland. Granulosa cells enlarge to become **granulosa lutein cells**, while theca interna cells form **theca lutein cells**, and a rich blood supply develops. Under the influence of LH, the corpus luteum secretes **progesterone and estrogen**. If pregnancy does not occur, it functions for about 10–12 days, then degenerates into a scar called the **corpus albicans**, leading to menstruation. If pregnancy occurs, **hCG** from the embryo maintains the corpus luteum, allowing continued progesterone

secretion to support the uterine lining and early embryo development.



Figure 6. Part of a corpus luteum. Granulosa lutein cells, which constitute the majority of the cells, derive from the granulosa layer. They are larger and stain more lightly than the theca lutein cells, which originate from the theca interna.

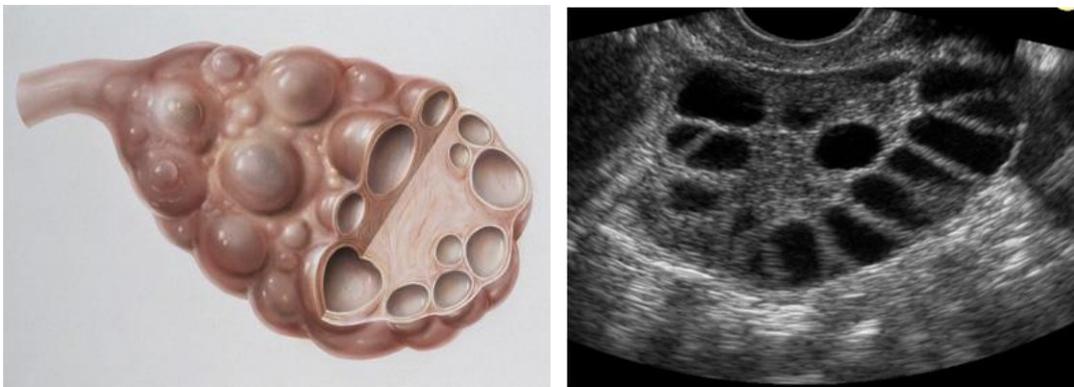
Interstitial cells:

The theca interna cells does not undergo atresia and frequently persist in isolation or in small groups throughout the cortical stroma and are called interstitial cells.



Polycystic ovary:

This is characterized by bilateral enlargement of the ovaries with numerous follicular cysts. Morphologically the ovaries like a small white balloon filled with tightly packed marbles, the affected ovaries are also called Oyster ovaries, have a smooth, pearl-white surface, and do not show surface scarring because no ovulation have occurred. The individual is **infertile** and has **oligomenorrhea**, scanty menstruation. The pathogenesis is not clear, but seems to be related to androgen biosynthesis that cause release of high amount of androgen, therefore the female develop **hirsutism**. The selection process of the follicles that undergo maturation also seems to be affected. The cycle is **anovulatory** cycle characterized by stimulation of endometrium by estrogen only.



Polycystic ovaries