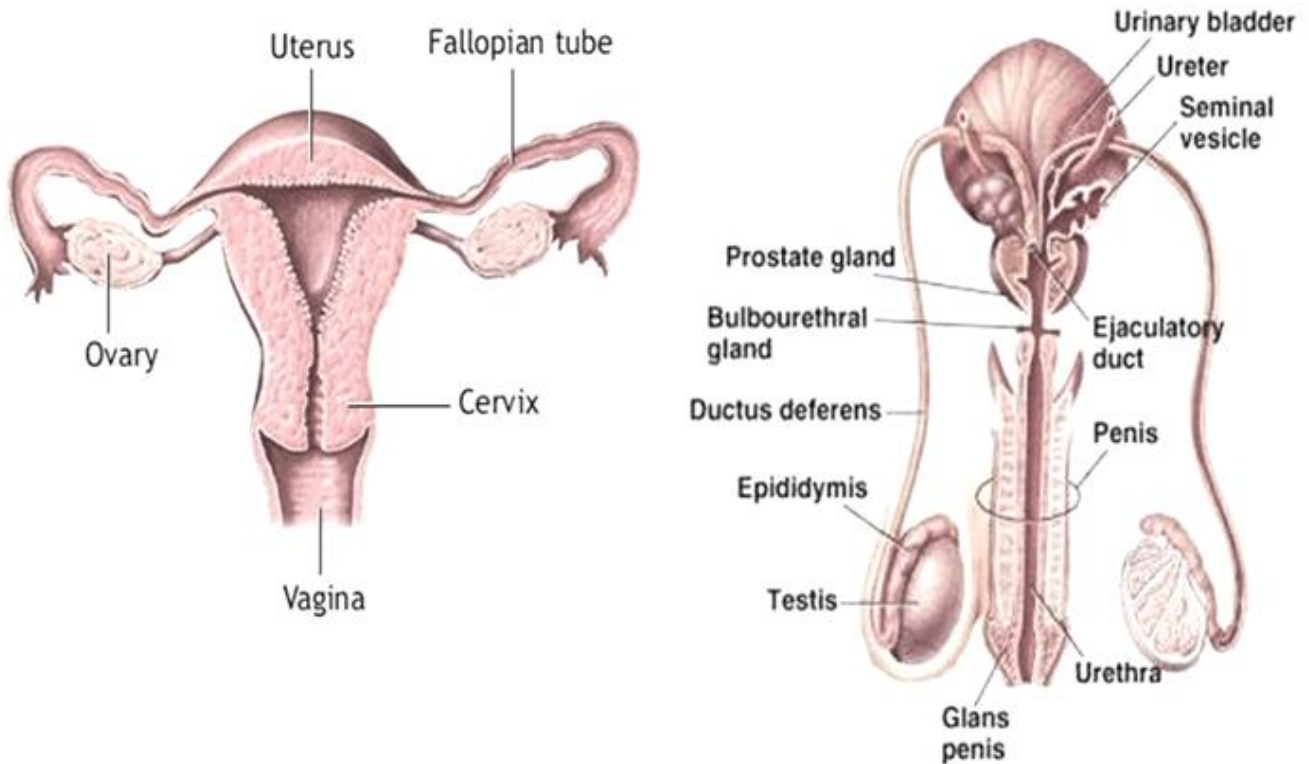


2nd Lecture Ovarian Cycle



PHYSIOLOGY TEAM – 430

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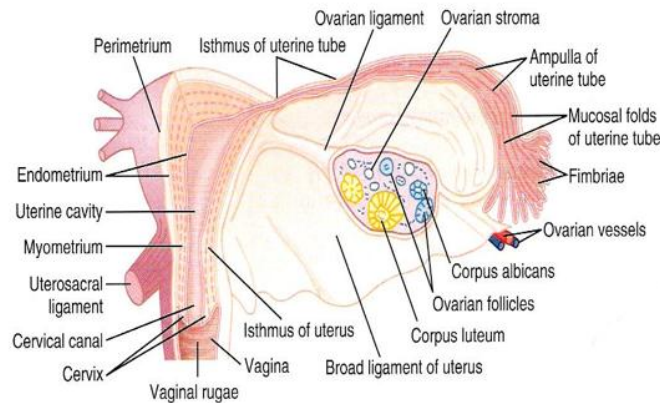
Ovarian Cycle

- **Monthly ovarian cycle:**

- Consists of Monthly rhythmical changes in the rates of secretion of female hormones with corresponding physical changes in the ovaries & other sexual organs

- **Duration of the cycle:**

- Average 28 days (20-45 days).
- There are 2 results of the female sexual cycle:
 1. **Single ovum is released** from the ovaries each month
 2. **Uterine endometrium is prepared** for implantation for the fertilized ovum.



- **Gonadotropic hormones and their effects on the ovaries:**

- The ovarian changes during the sexual cycle depend on **FSH & LH** secreted by AP. In the **absence** of these hormones, the ovaries remain **inactive** throughout childhood, **at puberty** the AP starts to **secrete** FSH & LH, which leads to the **beginning** of monthly sexual cycles. **First** menstrual cycle is called **menarche**
- **Both FSH and LH** stimulate their ovarian target cells by combining with **highly specific receptors** lead to increase the cells rates of secretion, growth & proliferation of the cells.

FSH & LH are responsible for the initiation of the monthly cycle once a female reaches puberty.

- **Ovarian follicle growth:**

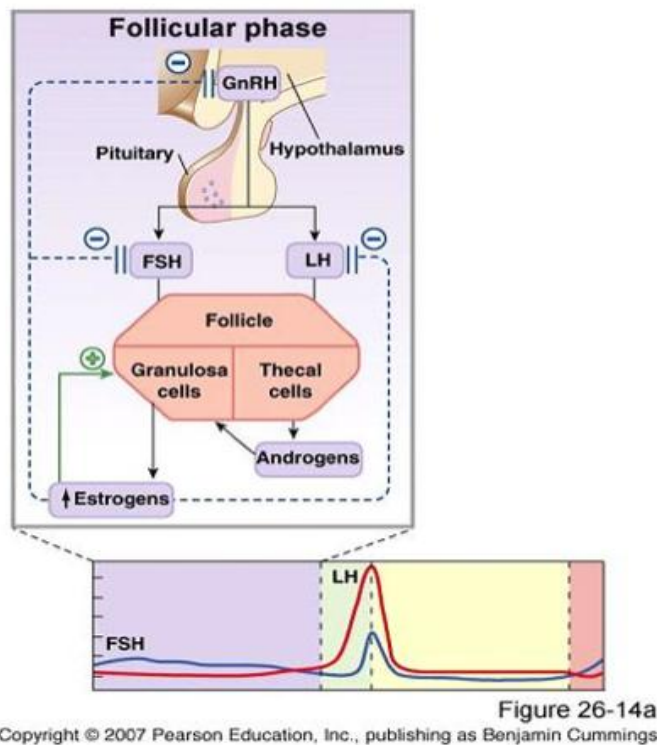
- **“Follicular” phase of the ovarian cycle:**

- In female child each ovum is surrounded by single granulosa cell sheath called primordial follicle.
- **During childhood**, the **granulosa cells** provide **nourishment** for the ovum & **secrete oocyte** maturation inhibiting factor, which keeps the ovum in its primordial state.
- **After puberty**, AP secretes **FSH and LH**, which **stimulate the ovaries** with some follicles to grow. This begins with enlargement of the ovum to increase in size & growth of additional layers of granulosa cells of some follicles & known as **primary follicles**.

The ovarian cycle consists of two phases:

1. The Follicular Phase
2. The Luteal Phase

Before Puberty	After Puberty
Primordial Follicle	Primary follicle
Single granulosa sheath	Additional layers of granulosa cells are added
Secretion of <i>oocyte maturation-inhibiting factor</i> (Keeps follicle in primordial state till puberty)	FSH & LH from the AP lead to the follicle's transformation from Primordial to Primary Follicle



- During the first few days of the monthly female sexual cycle there is increase secretion of **FSH and LH**.
- **FSH** increase is slightly **more & earlier** than **LH** which causes the **acceleration of growth** of many primary follicles each month. There is **proliferation of the granulosa cells** to many layers. The ovary interstitium collects in several layers outside the granulosa cells to form a second mass of cells called **theca**

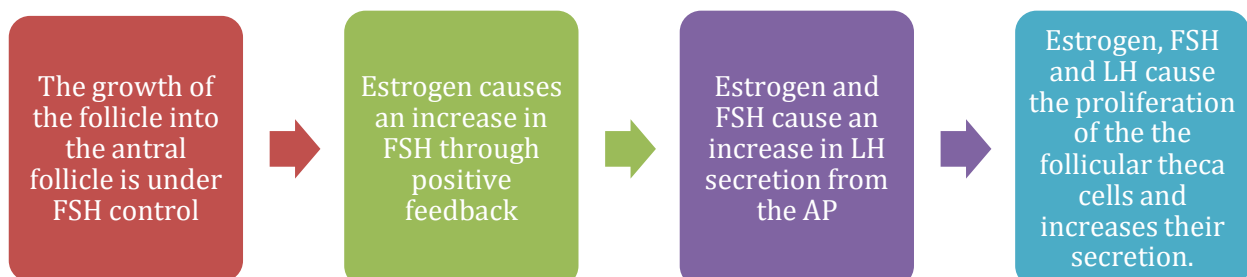
- FSH increases before LH does in order to allow the follicle to grow
- When it's time for ovulation LH is increased.

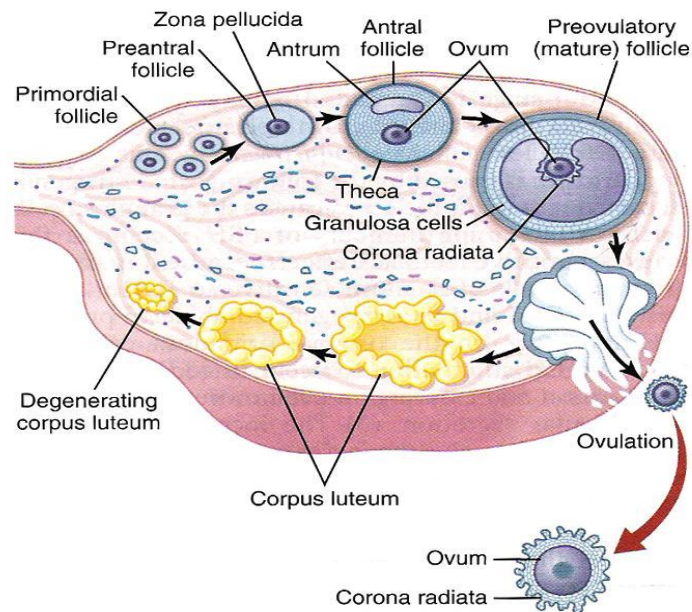
This theca is divided into 2 layers:

1. **Theca interna:** the cells have epitheloid characteristics and similar to the cells and **secrete sex hormones** (estrogen and progesterone)
2. **Theca externa:** the outer layer develops into a **highly vascular** connective tissue capsule of the developing follicle.

Interna → Hormones
(Estrogen, Progesterone)
Externa → Highly vascular

- A few days after proliferation & growth of the follicles, the granulosa cells secrete **follicular fluids** containing high concentrations of **estrogen**. This fluid accumulates to form the **antrum** within the mass of the granulosa cells.
- The early growth of the **follicle up to the antral follicle** is under **FSH** stimulation. Then there is accelerated growth of the follicles to larger follicle called **vesicular follicles** caused by:-
 1. **Estrogen secreted** into the follicle caused the granulosa cells to **increase FSH receptors**, which causes **positive feedback effect**;
 2. Both estrogen & FSH combine to **promote LH receptors** on the granulosa cells, allowing more increase follicular secretion;
 3. The increasing estrogen from the follicle plus increasing LH from the AP causes **proliferation of the follicular theca cells & increase their secretion**

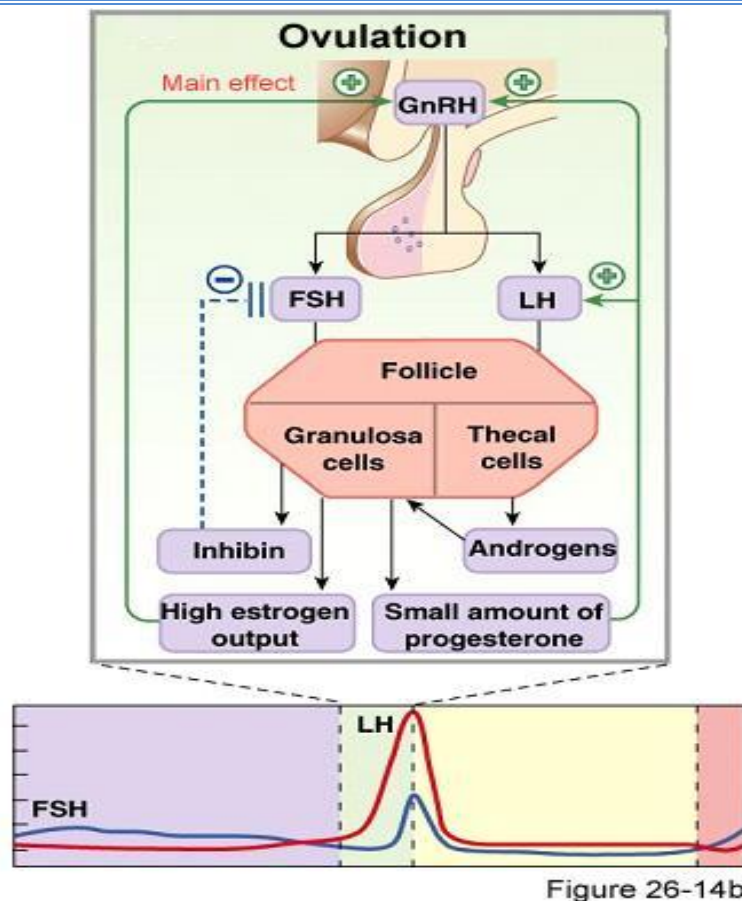




- The antral follicles begin to grow.
 - The ovum enlarges & remains embedded **at one pole of the granulosa cells** of the follicle.
 - **Only one follicle continues to grow** & the remaining follicles (5 to 11) undergo **atresia** or **involute**, the cause is unknown
 - Though it could be that the large amount of estrogen from the growing follicle inhibits further FSH secretion from the AP, while the largest follicle continues to grow because of the positive feedback effect.
 - A mature follicle reaches about 1 to 1.5 cm.
- **Ovulation:**
 - It occurs 14 days after the onset of menstruation in 28 days cycle (**mid cycle**).
 - Before ovulation, a small area in the center of the follicle called the **stigma protrudes & fluids ooze** from the follicle
 - The **stigma ruptures** allowing more viscous fluid outward carrying with it the ovum surrounded by mass of granulosa cells called **corona radiata**.
- LH surge is necessary for ovulation:**
- 2 days before ovulation, the **rate of LH secretion from the AP increases** markedly to 6-16 folds & peaks at about 16 hours before ovulation.
 - **FSH also increases** to 2 to 3 folds & acts synergistically with LH to cause swelling of the follicle before ovulation.
 - LH has specific effect on the granulosa cells & theca cells converting them to **progesterone secreting cells** so that the rate of estrogen secretion begins to fall about 1 day before ovulation while progesterone secretion begin to increase.

What hormone is responsible for ovulation?
LH

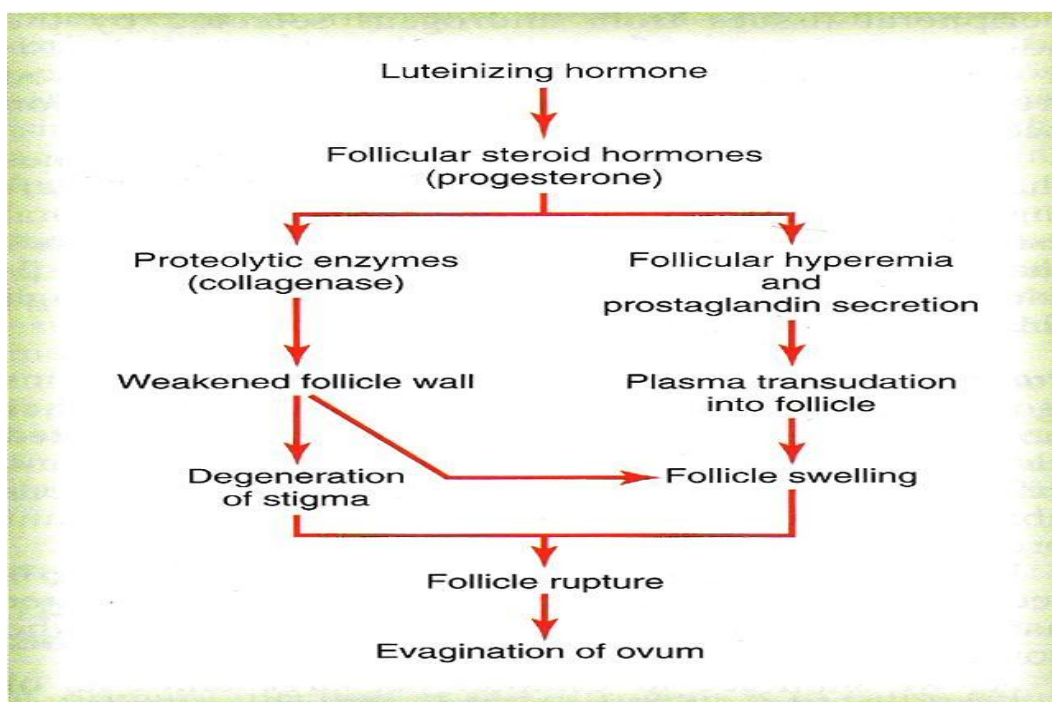
LH → Acts on granulosa and theca cells
→ turns them into progesterone secreting cells → more progesterone → less estrogen.

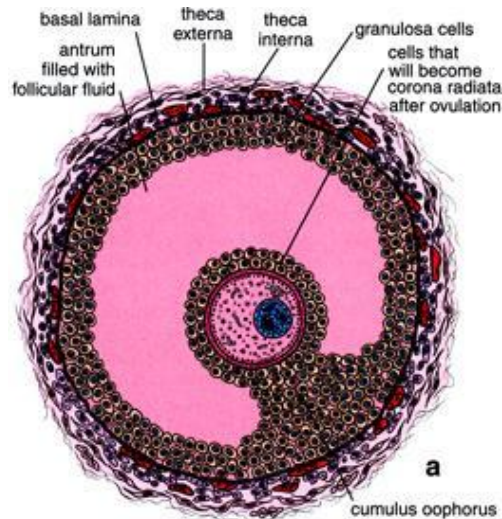


- **Initiation of ovulation:**

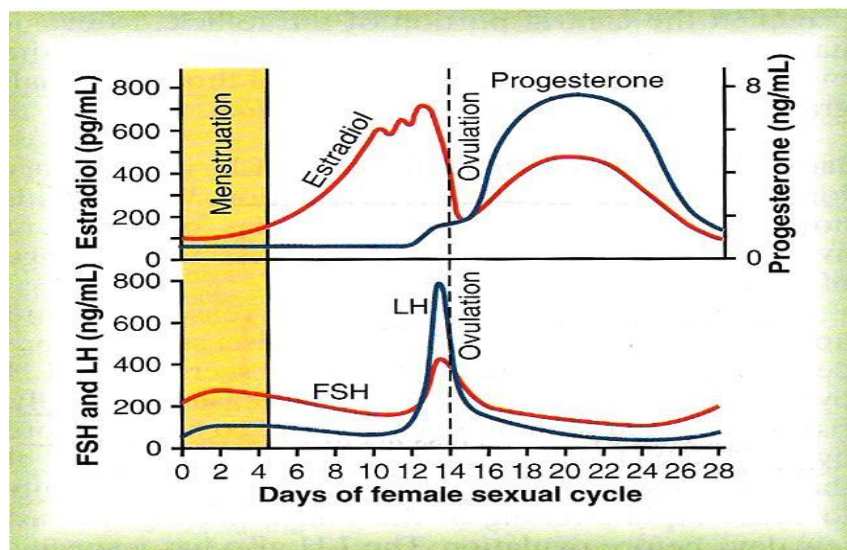
- Large quantity of LH secreted by the AP causes rapid secretion of progesterone from the follicle few hours
- 2 events occur which are necessary for ovulation:
 1. The theca externa begins to secrete proteolytic enzymes & causes weakening of the wall result in swelling of the follicle & degeneration of the stigma;
 2. Rapid growth of new blood vessels into the follicle wall & prostaglandins are secreted into the follicular tissue.

The two effects cause swelling of the follicle & plasma transudation into the follicle & degeneration of the stigma with discharge of the ovum.





MATURE GRAAFIAN FOLLICLE



• Luteal phase of the ovarian cycle:

- After expulsion of the ovum from the follicle, the remaining granulosa & theca interna cells change to lutein cells & become filled with lipid inclusions giving them a yellowish appearance. The granulosa cells with the theca cells called corpus luteum.
- The granulosa cells in corpus luteum develop extensive intracellular endoplasmic reticula & form large amount of progesterone & estrogen. The theca cells form mainly androgens, which are converted by granulosa cells into female hormones.
- The corpus luteum grows to about 1.5 cm in diameter, at about 7 to 8 days after ovulation. Then begins to involute & losses its secretory function & its yellowish characteristic about 12 days after ovulation & becomes corpus albicans which is replaced by connective tissue & absorbed.

The corpus Luteum is basically the layers that were containing the ovum, but without the ovum its self (after its expulsion)

Corpus Albicans is the corpus luteum after it becomes nonfunctional

• Luteinizing function of LH:

1. Changing the granulosa and theca interna cells into lutein cells.
 2. Extrusion of the ovum from the follicle.
 3. An uncharacterized local hormone in the follicular fluid called luteinization – inhibiting factor holds the luteinization process until after ovulation.
 4. Secretion of progesterone & estrogen from the corpus luteum.
- If pregnancy occurs, the chorionic gonadotropin from the placenta acts on the corpus luteum to prolong its life for 2 to 4 months of pregnancy.

- **Involution of the corpus luteum and onset of the next ovarian cycle:**

1. Estrogen & progesterone secreted by the corpus luteum in luteal phase have **strong negative feedback effect on AP** to inhibit the secretion of FSH & LH.
2. Lutein cells secrete small amounts of **inhibin**, which **inhibits the secretion of FSH by AP**.
3. **Low levels of both FSH, LH & loss of these hormones** causes the corpus luteum to degenerate completely, called **involution of the corpus luteum**.
4. **Around the 26th days of normal sexual cycle & after involution of the corpus luteum**, sudden **cessation of secretion of estrogen, progesterone & inhibin** removes the feedback inhibition of the AP & allowing **increase secretion of FSH & LH again**
5. FSH & LH initiate the **growth of new follicles**, beginning a **new ovarian cycle**.

Estrogen and Progesterone → Negative feedback on AP →
Low LH and FSH → Corpus Luteum degeneration (involution)
(Because there was no fertilization → No pregnancy → it's not needed anymore)

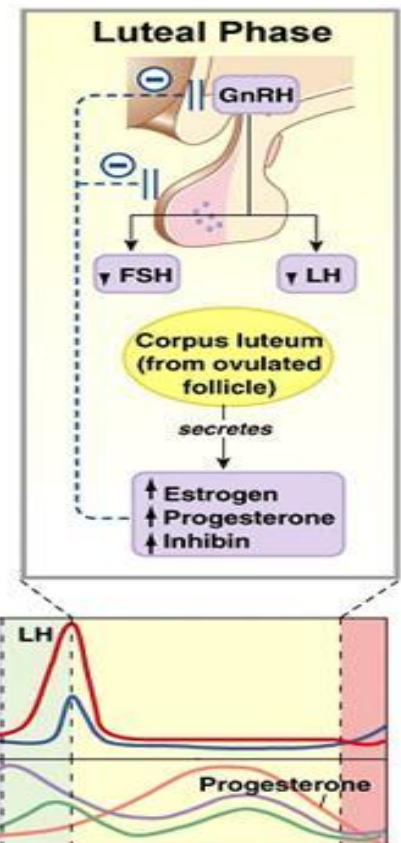


Figure 26-14c

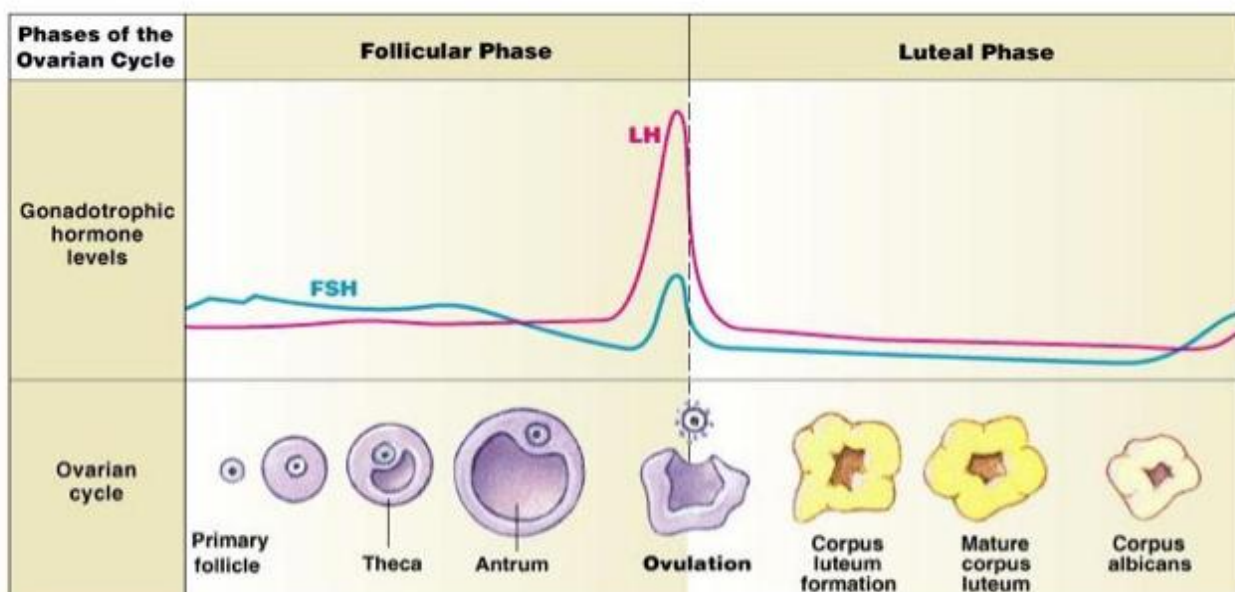


Fig. 26-13

