



Physiology Team 431
Reproductive Block

Lecture 3

Physiology of ovarian cycle

Done by : Sarah Aldokhi & Ahmed Al-Marzoqi

Revised by : Nour Al-Khawajah & Mohammed Asiri

Physiology of ovarian cycle

Objectives:

By the end of this lecture, you should be able to:

List the hormones of female reproduction and describe their physiological functions

Describe the changes that occur in the ovaries during the menstrual cycle

Describe the hormonal control of the development of ovarian follicles, mature oocytes and corpus luteum

Describe the pituitary ovarian axis and in correlation with the changes that occur in the ovaries leading up to and following ovulation during an ovarian cycle

Keywords: 17β -estradiol, progesterone, graafian follicle, ovulation, corpus luteum

Monthly ovarian cycle:

Monthly rhythmical changes in the rates of secretion of female hormones & 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:

Single ovum is released from the ovaries each month

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 lead 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 cell During each month of the female sexual cycle, there is a cyclical increase and decrease of both FSH and LH.

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:

1/ provide nourishment for the ovum

2/ secrete oocyte maturation inhibiting factor which keeps the ovum in its primordial state.

After puberty:

AP secrete 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**. **First thing to grow and appear after primordial follicle.**

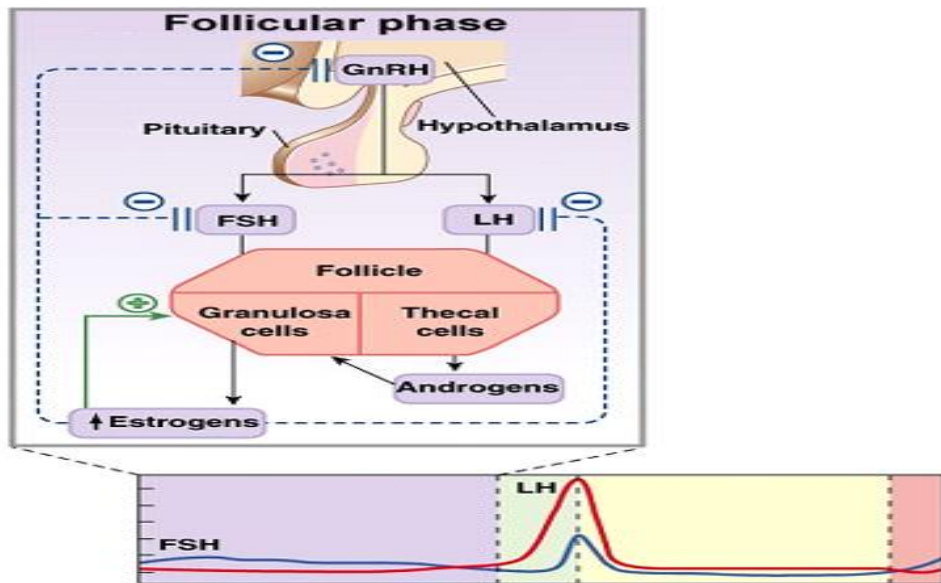
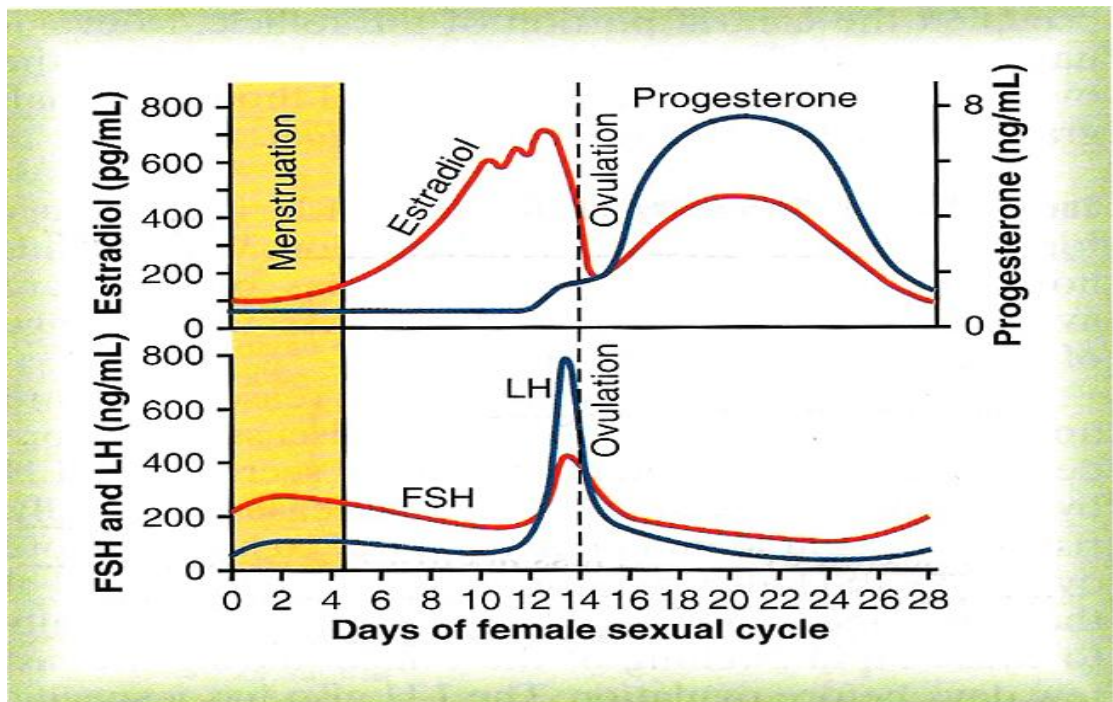


Figure 26-14a

Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.



Advice: read and try to understand the lecture before studying this graph.

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 collect in several layers outside the granulosa cells to form a second mass of cells called theca.

This theca is divided into 2 layers:

theca interna, the cells have epitheloid characteristics and similar to the granulosa cells and secrete sex hormones (estrogen and progesterone)

theca externa, the outer layer, develops into a highly vascular connective tissue capsule of the developing follicle.

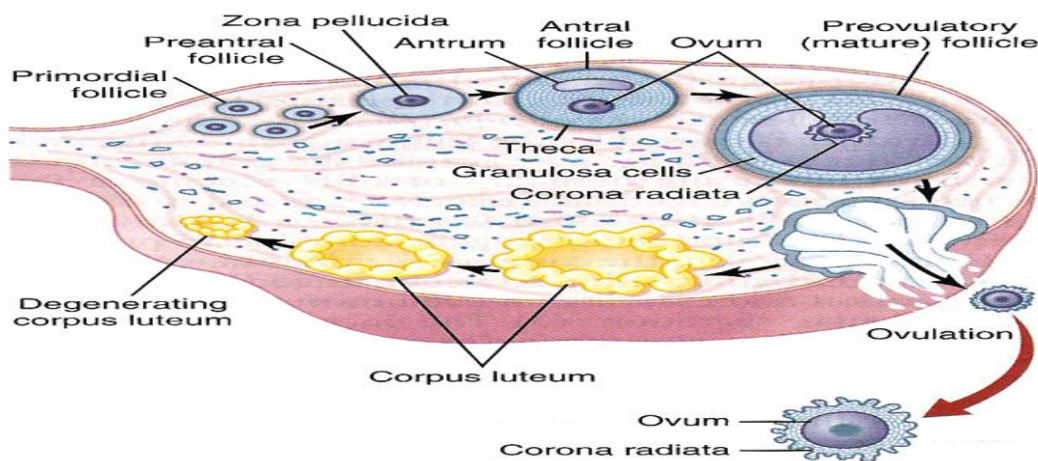
Few days after proliferation & growth of the follicles, the granulosa cells secrete **follicular fluids** contain high concentration of estrogen. This fluid accumulate to form **antrum** within the mass of the granulosa cells.

The early growth of the follicle up to the antral is under **FSH** stimulation. Then there is accelerated growth of the follicle to larger follicle called **vesicular follicle** caused by:-

1-estrogen secreted into the follicle caused the granulosa cells to increase FSH receptors which causes **positive feedback effect**;

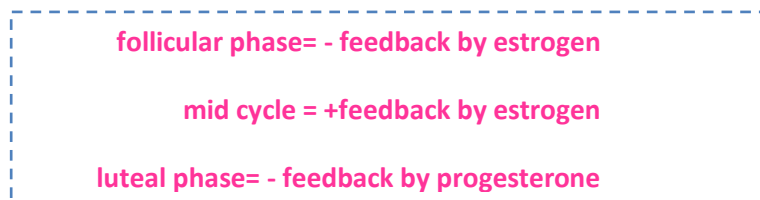
2-both estrogen & FSH combine to promote LH receptors on the granulosa cells, allowing more increase follicular secretion;

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. Once the antral follicles begin to grow, their growth occurs almost explosively. And the ovum diameter increases about 10 folds so the enlarged ovum remain embedded at one pole of the granulosa cells of the follicle.

- Only one follicle continue to grow & the remaining follicles (5 to 11) **undergo atresia or involute** the cause is unknown or could be that large amount of estrogen from the growing follicle inhibit further FSH secretion from the AP, while the largest follicle continue to grow because of the positive feedback effect & mature follicle reach about 1 to 1.5 cm.



Ovulation:

Always remember that the exact day of ovulation is :

(The ovarian cycle in days – 14) so the increase or decrease in the menstrual cycle is always controlled by the follicular phase.

It occurs 14 days after the onset of menstruation in 28 days cycle. Before ovulation, small area in the center of the follicle called stigma protrude & 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**.

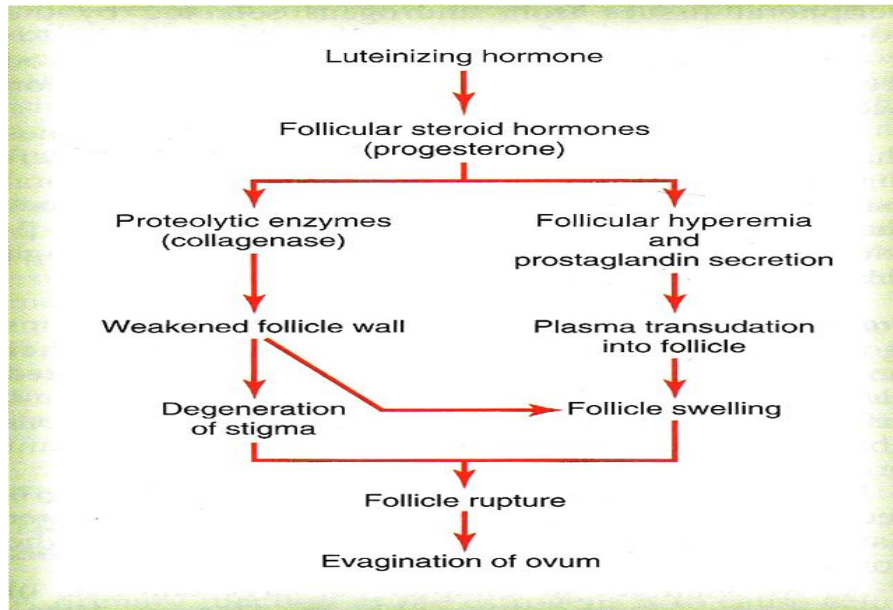
LH surge is necessary for ovulation:

2 days before ovulation, the rate of LH secretion from the AP increase markedly to 6-10 fold & peaking about 16 hrs before ovulation for unknown reason. This hormone is necessary for the follicular ovulation. Without this hormone, even when large quantities of FSH are available, the follicle will not progress to the stage of ovulation.

- FSH also increases to 2 to 3 fold & 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 the rate of estrogen secretion begins to fall about 1 day before ovulation while progesterone secretion begin to increase.

It is in this environment of (1) rapid growth of the follicle, (2) diminishing estrogen secretion after a prolonged phase of excessive estrogen secretion, and (3) initiation of secretion of progesterone that ovulation occurs. Without the initial preovulatory surge of LH, ovulation will not take place.



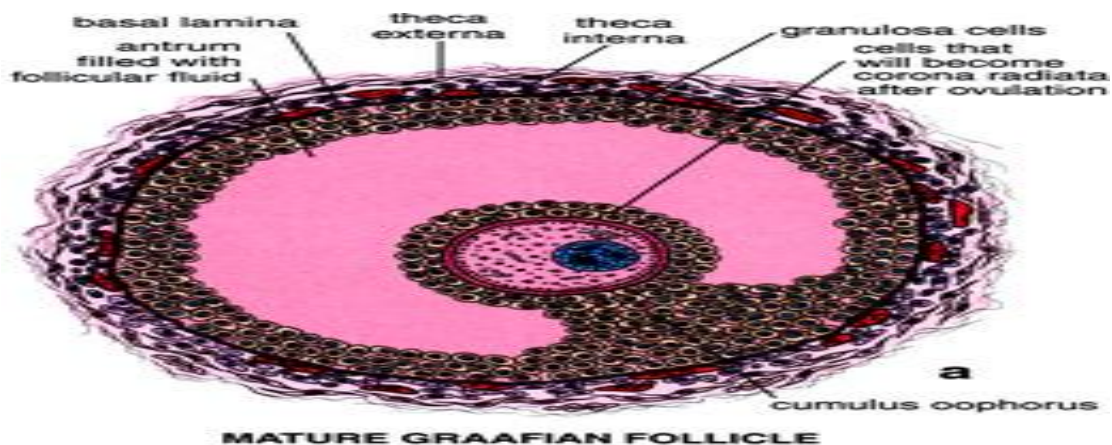
Initiation of ovulation:

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 causes swelling of the follicle & plasma transudation into the follicle & degeneration of the stigma with discharge of the ovum.



Luteal phase of the ovarian cycle:

- After expulsion of the ovum from the follicle, the remaining granulosa & theca internal cells change to lutein cells & become filled with lipid inclusions giving them yellowish appearance. **The granulosa cells with the theca cells called corpus luteum.**

- The granulosa cells in corpus luteum develop extensive intracellular smooth endoplasmic reticula & form large amount of progesterone & estrogen. The theca cells form mainly androgens androstenedione and testosterone rather than female hormones. However most of these hormones are converted in granulosa cells into female hormones by enzyme aromatase.

- The corpus luteum grow 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 & replaced by connective tissue & absorbed.

Luteinizing function of LH:

1- The change of granulosa and theca interna cells into lutein cells.

2- Extrusion of the ovum from the follicle Uncharacterized local hormone in the follicular fluid called luteinization – inhibiting factor hold the luteinization process until after ovulation.

3- Secretion of progesterone & estrogen from the corpus luteum.

- If pregnancy occur, the chorionic gonadotropin from the placenta act 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- The lutein cells secrete small amounts of inhibin which inhibit secretion of FSH by AP. Low levels of both FSH & LH & loss of these hormones causes the corpus luteum to degenerate completely, called involution of the corpus luteum.

3- Around 26th days of normal sexual cycle & after involution of corpus luteum, sudden cessation of secretion of estrogen, progesterone & inhibin removes the feedback inhibition of the AP & allowing increase secretion of FSH & LH again. FSH & LH initiate the growth of new follicles, beginning a new ovarian cycle.

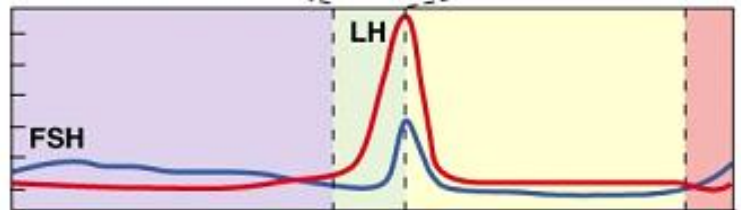
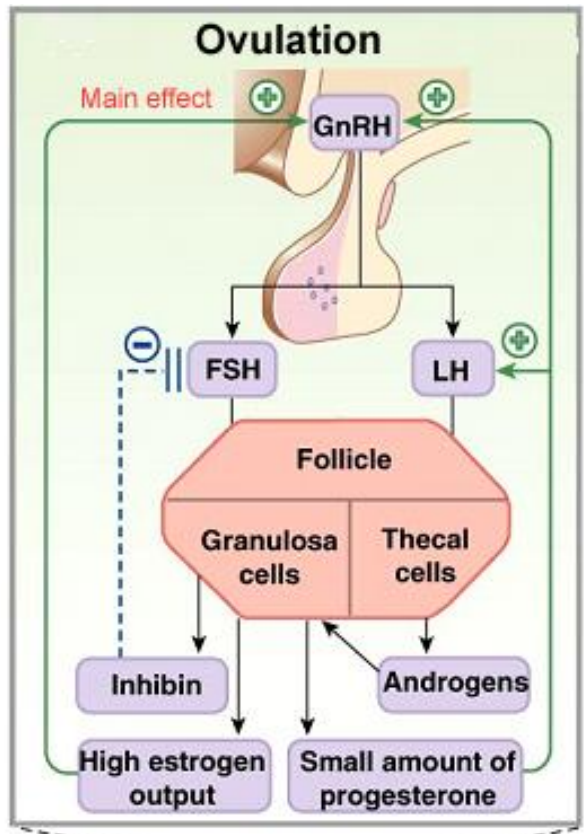


Figure 26-14b

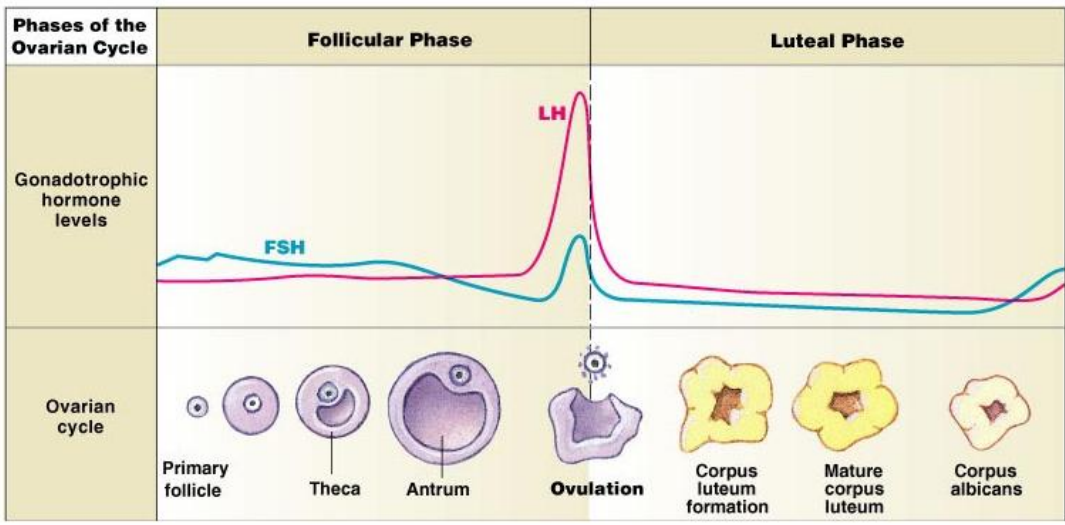


Fig. 26-13

summary:

About every 28 days, gonadotropic hormones from the anterior pituitary gland cause about 8 to 12 new follicles to begin to grow in the ovaries. One of these follicles finally becomes "mature" and ovulates on the 14th day of the cycle. During growth of the follicles, mainly estrogen is secreted.

After ovulation, the secretory cells of the ovulating follicle develop into a corpus luteum that secretes large quantities of both the major female hormones, progesterone and estrogen. After another 2 weeks, the corpus luteum degenerates, whereupon the ovarian hormones estrogen and progesterone decrease greatly, and menstruation begins. A new ovarian cycle then follows.

In females the ovaries are responsible for oogenesis and secretion of progesterone and estrogen.

2- progesterone and estrogen are synthesized from cholesterol by theca and granulosa cells.

3- the follicular phase is dominated by estrogen.

4- Luteal phase is dominated by progesterone.

5- ovulation occurs on day 14 of a 28 day menstrual cycle.

6- If fertilization occurs, the corpus luteum synthesizes steroid hormones to support the developing zygote, but if the fertilization does not occur, the corpus luteum regresses and menses occurs.

1- which cell produces estrogen that mainly enters the follicular fluid ?

- a) Theca cell
- b) Leydig cell
- c) luteal cell
- d) granulosa cell**

2- which one of the following occurs during the proliferative phase of the uterine cycle?

- a) The blood estrogen level reach high peak**
- b) Constriction of the spiral arteries in the endometrium
- c) Progesterone is the dominant hormone
- d) The uterine glands decrease in length

3- which hormone causes ovulation?

- a) LH hormone**
- b) FSH hormone