



REBRODUCTIVE BLOCK



LECTURE 3

PHYSIOLOGY OF OVARIAN CYCLE

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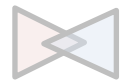
BELIEVE YOU CAN & YOU'RE
HALFWAY THERE!
THEODORE ROOSEVELT

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

1. List the hormones of female reproduction and describe their physiological functions.
2. Describe the changes that occur in the ovaries during the menstrual cycle.
3. Describe the hormonal control of the development of ovarian follicles, mature oocytes and corpus luteum.
4. 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:

17 β -estradiol, progesterone, graafian follicle, ovulation, corpus luteum.



Monthly Ovarian Cycle

- Changes in the rates of secretion of female hormones.
- Corresponding physical changes in the ovaries & other sexual organs.
- Outcomes of the cycle.

Hypothalamic Pituitary Ovarian Axis

- FSH & LH are necessary during sexual cycle.

Follicular Phase

- FSH & estrogen are the predominant hormones.
- Only one follicle continues to grow & the remaining follicles undergo atresia or involute.

Ovulation

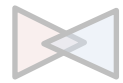
- On day 14, assuming a 28 day cycle.
- LH surge.
- Initiation of ovulation.

Luteal Phase

- Luteinization process.
- Secretions of lutein cells.
- Corpus luteum formation & involution.
- Progesterone is the predominant hormone.



- [1. Phases of The Ovarian Cycle: Overview from Puberty to Menopause:](#)
- [2. HPG Axis: Hormonal Control of the Ovarian Cycle:](#)
- [3. Follicular Phase of the Ovarian Cycle](#)
- [4. Luteal Phase of the Ovarian Cycle:](#)

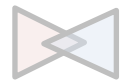


Monthly Ovarian Cycle:

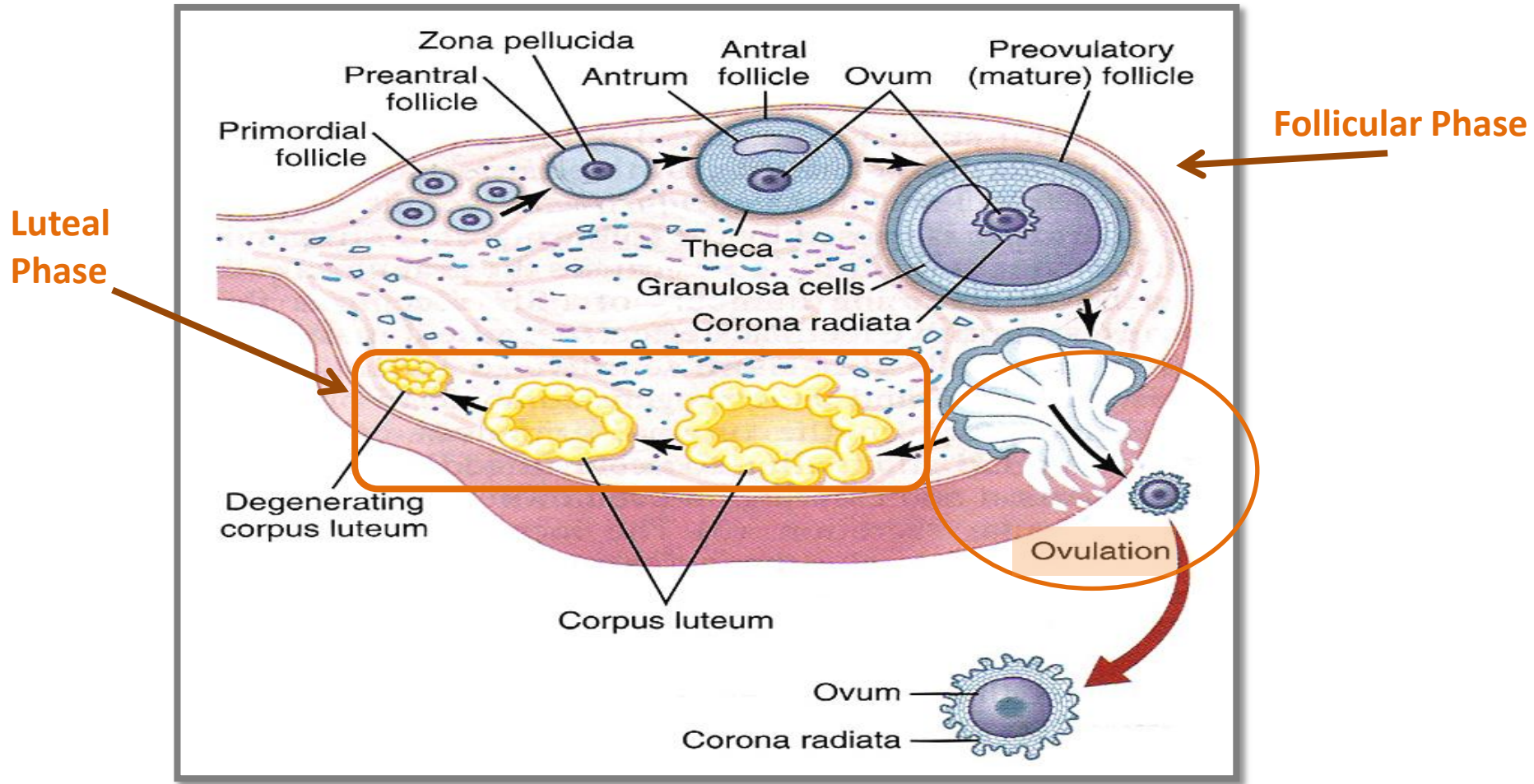
- Monthly rhythmical changes in the rates of secretion of female hormones & corresponding physical changes in the ovaries & other sexual organs (**endometrial lining of uterus**).
- **The duration of the cycle** averages 28 days. It may be as short as 20 days or as long as 45 days in some women.
- There are 2 results of the female sexual cycle:
 1. **Single ovum** is released from the ovaries **each month**, so normally only a single fetus will begin to grow at a time.
 2. Uterine endometrium is prepared for implantation of the fertilized ovum.

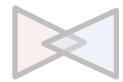
Gonadotropic Hormones and Their Effects on the Ovaries:

- The ovarian changes during the sexual cycle **depend completely** on **FSH & LH** secreted by anterior pituitary gland (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 cells.



Progressive stages of follicular growth in the ovaries, also showing formation of the corpus luteum.





“Follicular” Phase of the Ovarian Cycle:

When a **female child** is born

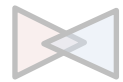
- When a female child is born, each **ovum** is surrounded by single layer of **granulosa cell sheath** called **primordial follicle**.

During **childhood**

- 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**

- 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**.

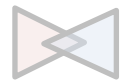


Development of Antral and Vesicular Follicles:

- 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 **6 to 12 primary follicles** each month.
- The initial effect is proliferation of the granulosa cells to many more 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	Theca externa
<ul style="list-style-type: none">• the cells have epithelioid characteristics and similar to the granulosa cells and secrete sex hormones (estrogen and progesterone).	<ul style="list-style-type: none">• the outer layer, develops into a highly vascular connective tissue capsule of the developing follicle.



Development of Antral and Vesicular Follicles

- Few days after early 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 stage is under **FSH stimulation mainly**.

Then there is accelerated growth of the follicle leading to larger follicle called vesicular follicle *caused by:*

1. Estrogen is secreted into the follicle & causes the granulosa cells to increase FSH receptors which causes positive feedback effect because it makes the granulosa cells even more sensitive to FSH.
 2. Both estrogen & FSH combine to promote LH receptors on the granulosa cells, allowing more increase in follicular secretion.
 3. The increasing estrogens from the follicle plus increasing LH from the AP cause proliferation of the follicular theca cells & increase their secretion as well.
- The antral follicles begin to grow. The ovum enlarges & 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 reaches about 1 to 1.5 cm.

***From Guyton:** This process of atresia is important because it normally allows only one of the follicles to grow large enough each month to ovulate; this usually prevents more than one child from developing with each pregnancy. The single follicle reaches a diameter of 1 to 1.5 centimeters at the time of ovulation and is called the mature follicle.*

“Follicular” Phase of the Ovarian Cycle:

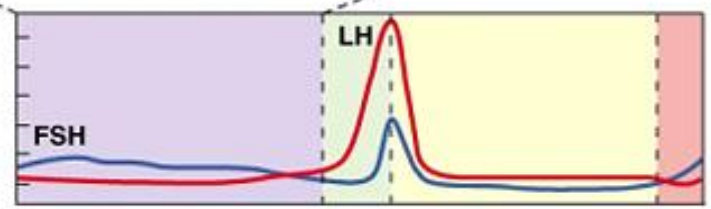
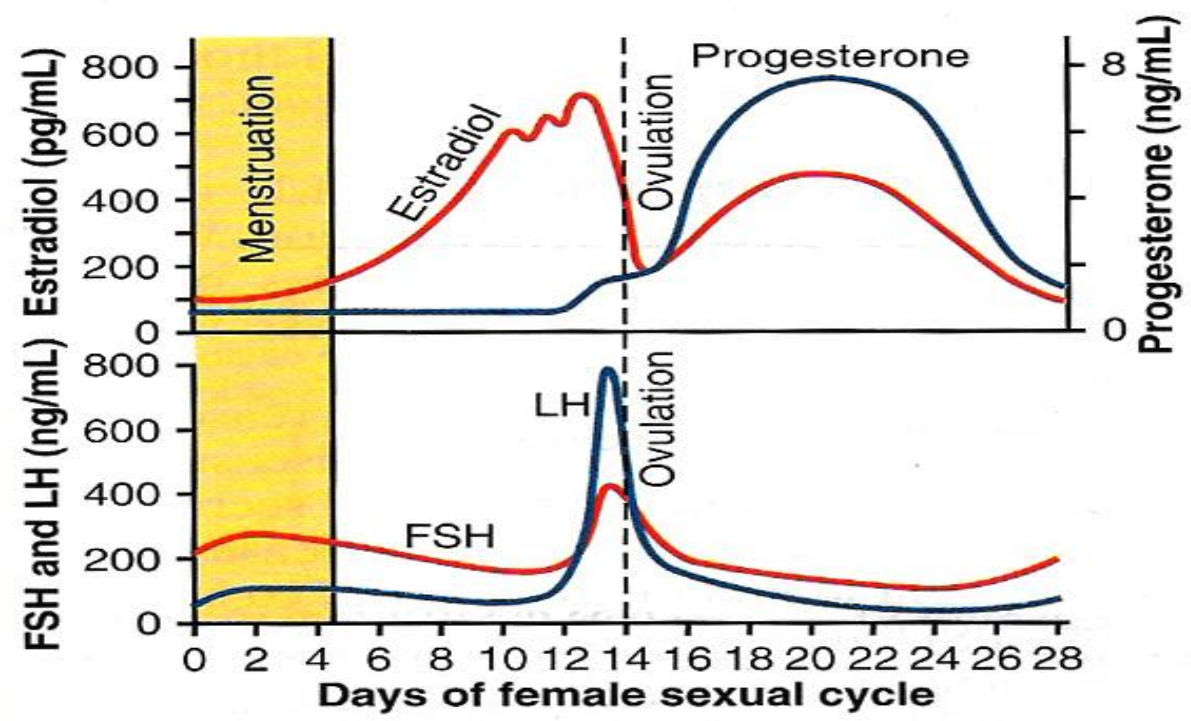
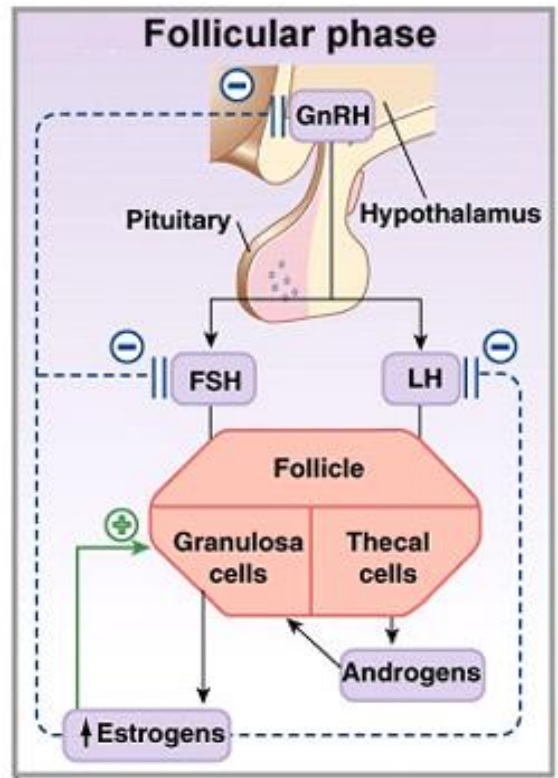


Figure 26-14a

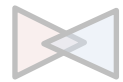
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Ovulation:

- 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 like a nipple & fluids ooze from the follicle through the stigma.
- Later, the stigma ruptures allowing more viscous fluid outward carrying with it the ovum surrounded by mass of granulosa cells called **corona radiata**.

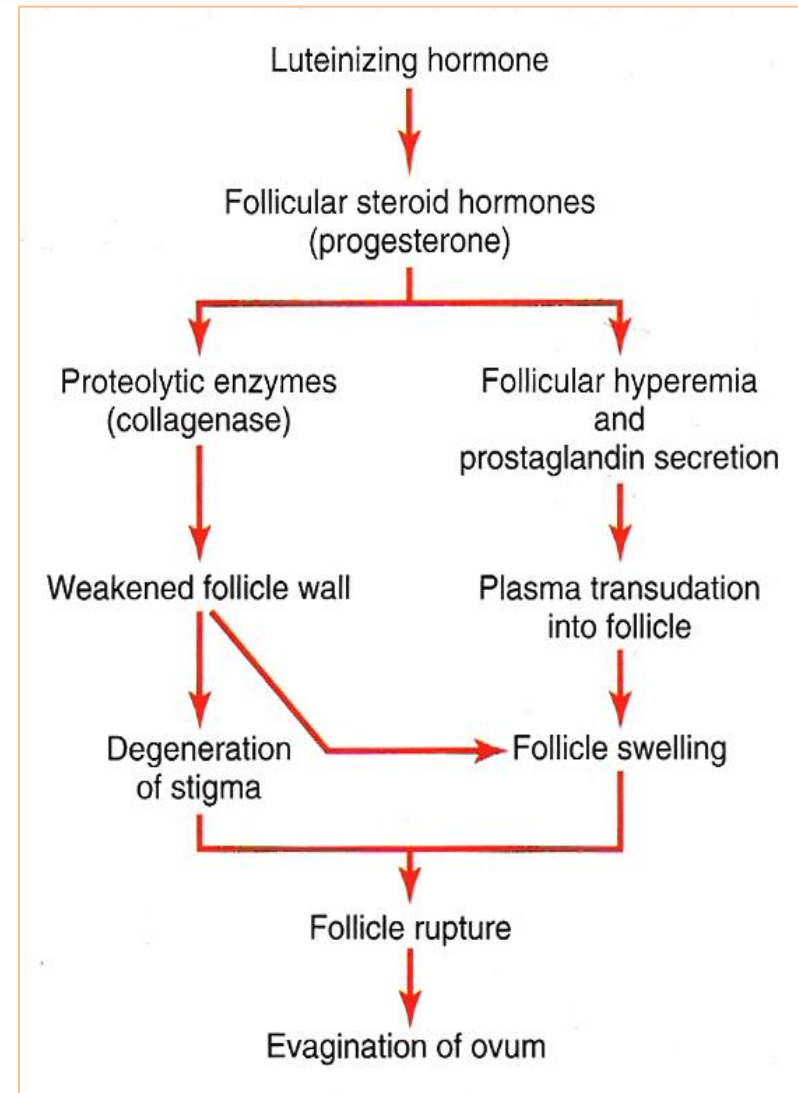
LH surge is necessary for ovulation:

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



Initiation of Ovulation:

- LH causes rapid secretion of progesterone.
- **Within a few hours, two events occur, both of which are necessary for ovulation:**
 - (1) The theca externa (the capsule of the follicle) begins to **release proteolytic enzymes** and these cause dissolution of the follicular capsular wall → weakening of the wall → further swelling of the entire follicle and degeneration of the stigma.
 - (2) Simultaneously there is **rapid growth of new blood vessels into the follicle wall (hyperemia)**, and at the same time, **prostaglandins** are secreted into the follicular tissue.
- These two effects cause plasma transudation into the follicle, which contributes to follicle swelling.
- Finally, the combination of follicle swelling and simultaneous degeneration of the stigma causes follicle rupture, **with discharge of the ovum**.



Ovulation (Cont.)

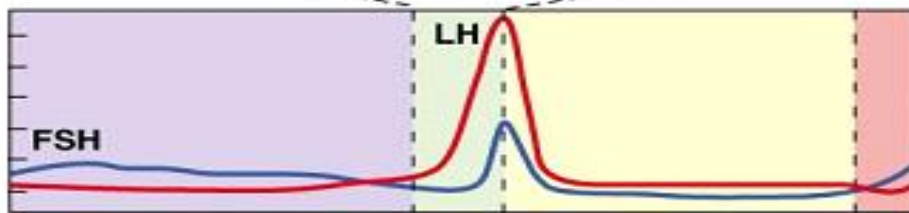
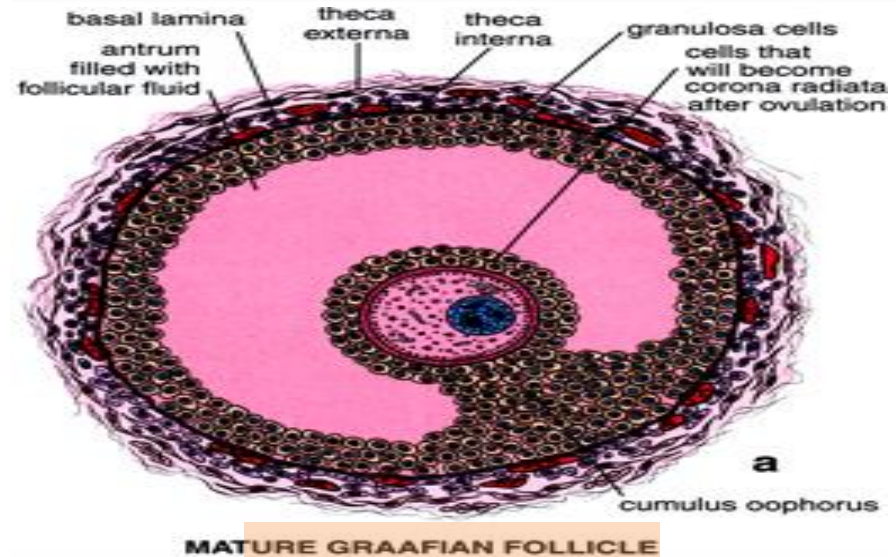
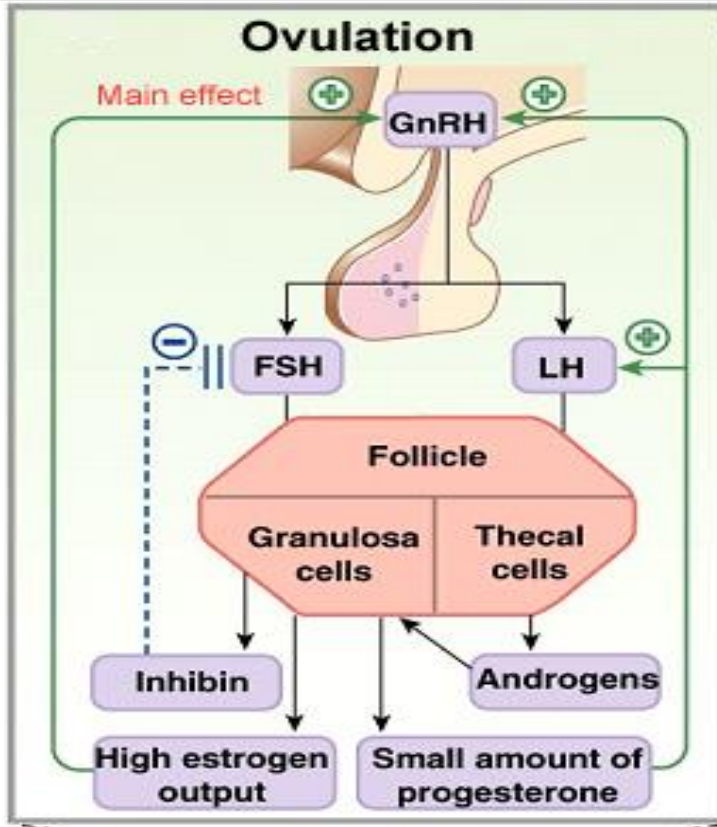
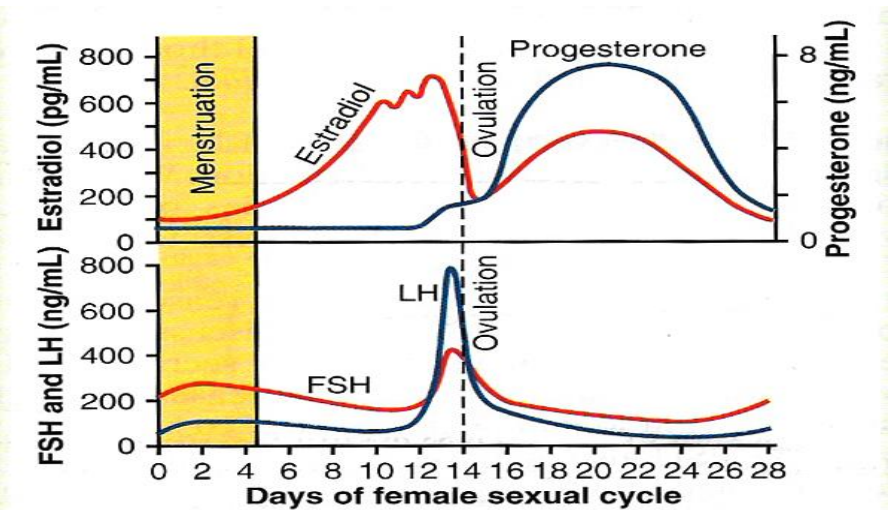


Figure 26-14b



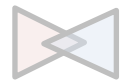
SLIDES

IMPORTANT

FEMALES' NOTES

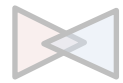
EXPLANATION

MALES' NOTES



“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. This process is called **luteinization**.
- The granulosa cells with the theca cells are 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 which are converted by granulosa cells into estrogens, the female hormones.
- 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 is dependent mainly on LH.
- 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 occurs, 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 the 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 hormone** which inhibits 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.

“Luteal” Phase of the Ovarian Cycle:

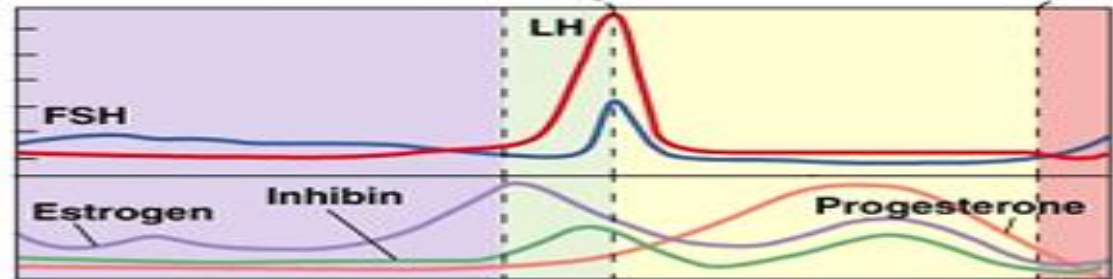
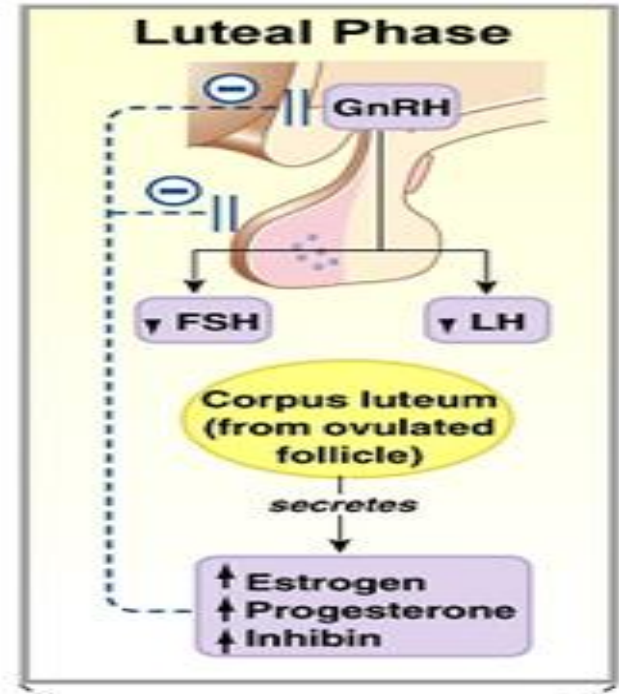
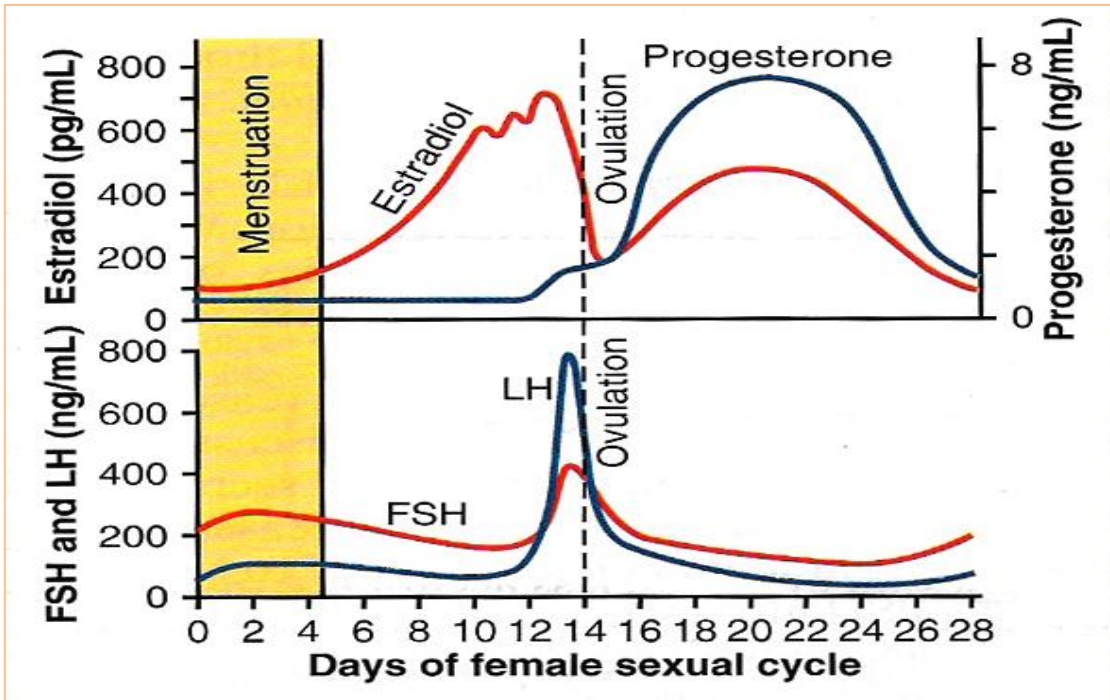


Figure 26-14c

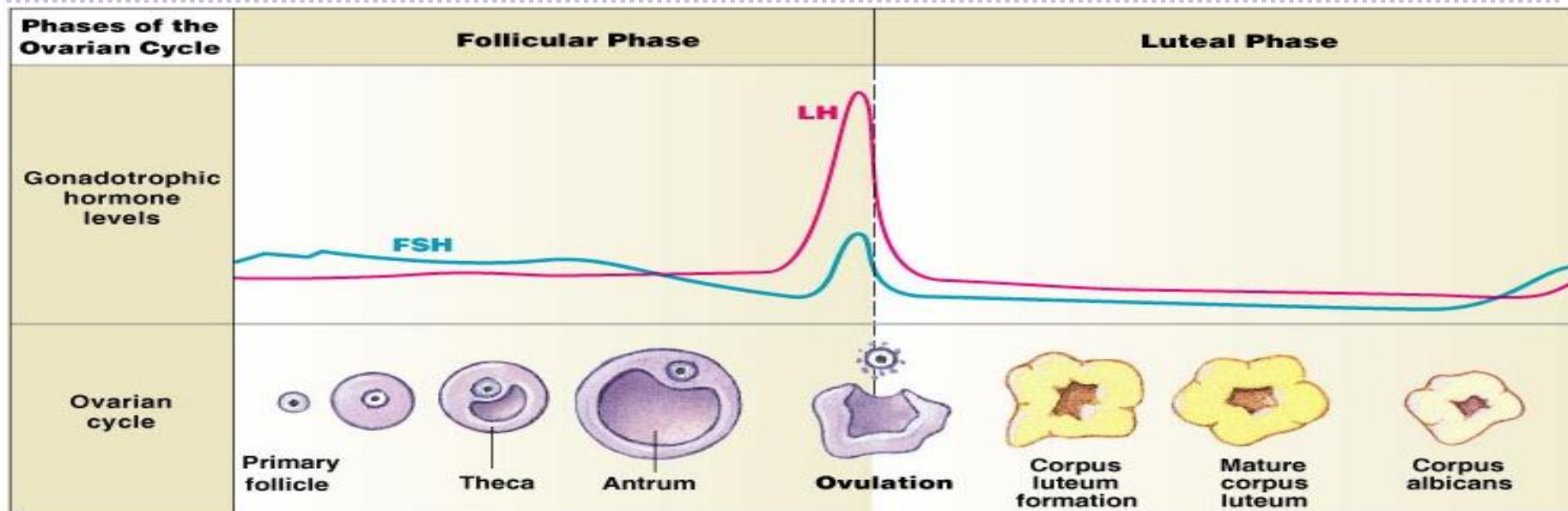


SUMMARY

From Guyton

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.



■ SLIDES

■ IMPORTANT

■ FEMALES' NOTES

■ EXPLANATION

■ MALES' NOTES



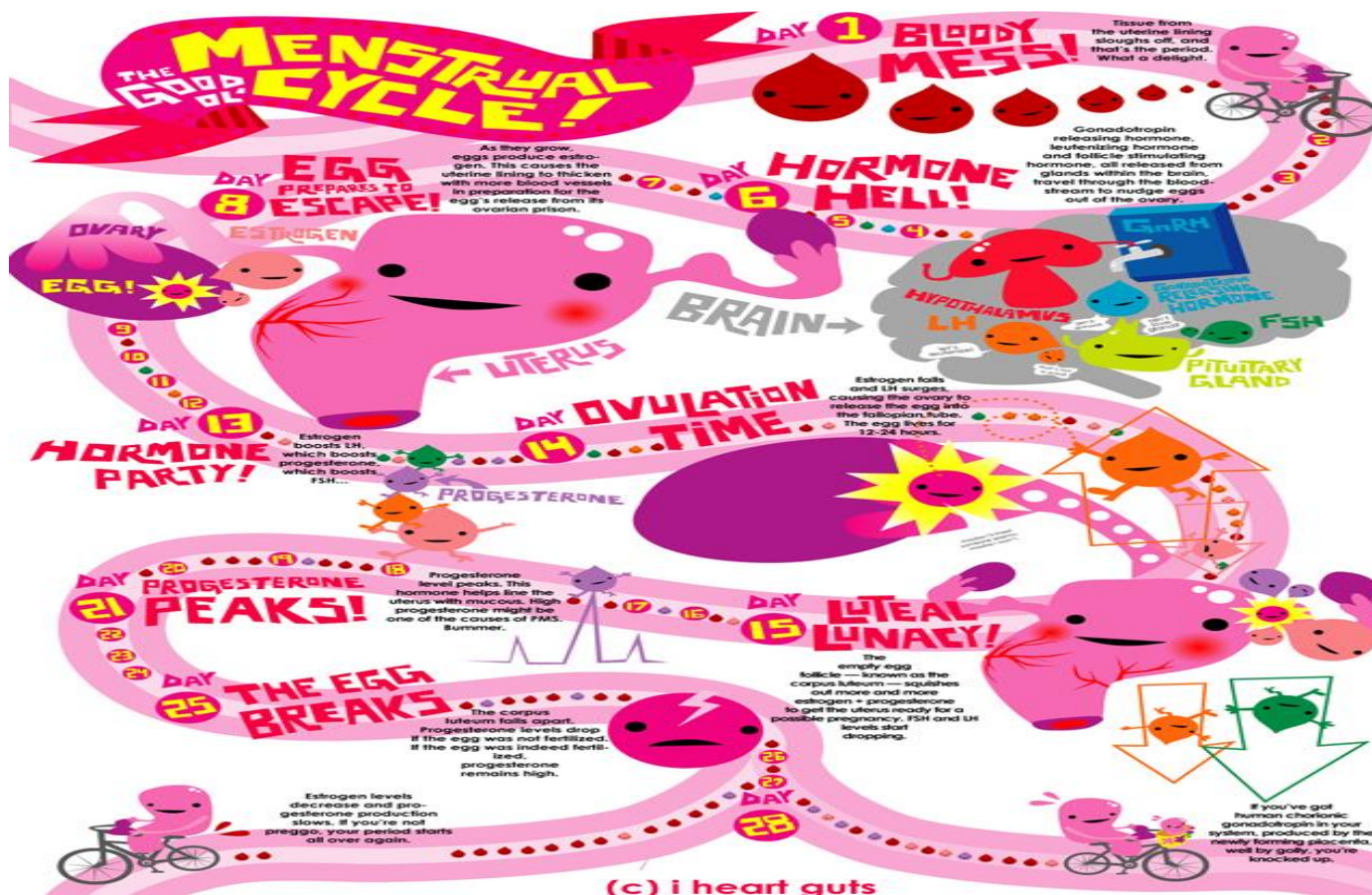
SUMMARY

Phases of Ovarian Cycle Along with Uterine Cycle

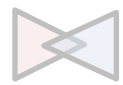
Ovarian Cycle	Events	Uterine Cycle	Events
Follicular phase - Days 1-13	FSH secretion begins, Follicle maturation occurs, Estrogen secretion is prominent	Menstruation - Days 2-5 Proliferative phase - Days 6-13	Endometrium breaks down Endometrium rebuilds
Ovulation - Day 14*	LH spike occurs		
Luteal phase - Days 15-28	LH secretion continues, Corpus luteum forms, Progesterone secretion is prominent	Secretory phase - Days 15-28	Endometrial thickens, and glands are secretory

(*)Assuming a 28 day cycle.

<http://toosogle-pregnancy.blogspot.com/>



Very nice and simple short flash videos (It's highly recommended). [Here](#) [Here](#)



QUESTIONS

1. The theca mass of cells are formed by:

- A) Primary follicle.
- B) Granulosa cells.
- C) Ovary interstitium.
- D) Fluid accumulation.

2. The level of estrogen secretion 1 day before ovulation:

- A) The same as progesterone.
- B) Increase.
- C) Decrease.
- D) Constant.

3. When the oocyte is released from the follicle, it's:

- A) Not surrounded by any cell.
- B) Surrounded by granulosa cells.
- C) Surrounded by theca internal cells.
- D) Surrounded by corona radiata.

4. The theca cells in corpus luteum secrete:

- A) Adrenaline.
- B) Androgen.
- C) Estrogen.
- D) Progesterone.

5. Which hormone is acting on corpus luteum to prolong its life during pregnancy?

- A) Chorionic gonadotropin..
- B) Human placental lactogen.
- C) Progesterone.
- D) Androgen.

1	C
2	C
3	D
4	B
5	A

THE END

**IF THERE ARE ANY PROBLEMS OR
SUGGESTIONS,
FEEL FREE TO CONTACT US:**

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THANK YOU



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Actions Speak Louder Than Words