Female Physiology Before Pregnancy and Female Hormones-I

Unit XIV

Chapter 82

Dr Iman Aolymat

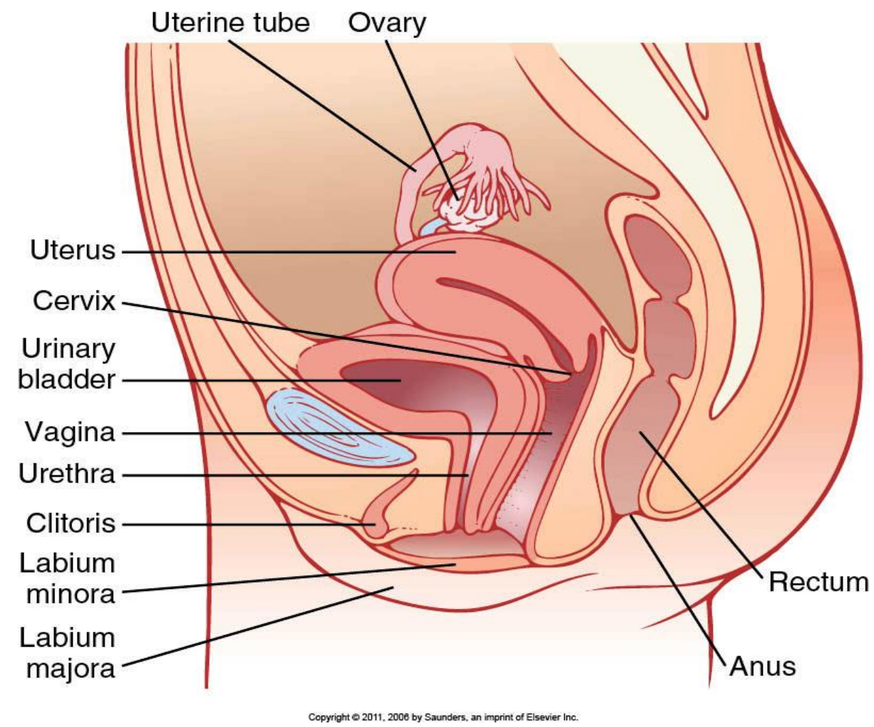
Physiological anatomy of the female sexual organs

- **<u>Primary sex organs</u>**

➢ Ovaries

✓ Gametogenic→ site of follicular development and production of 2nd oocytes

✓ Endocrine→ hormones (E&P)

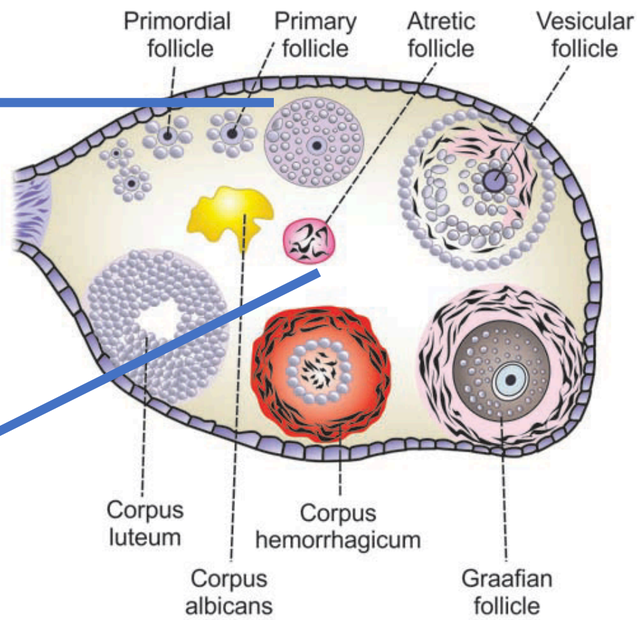


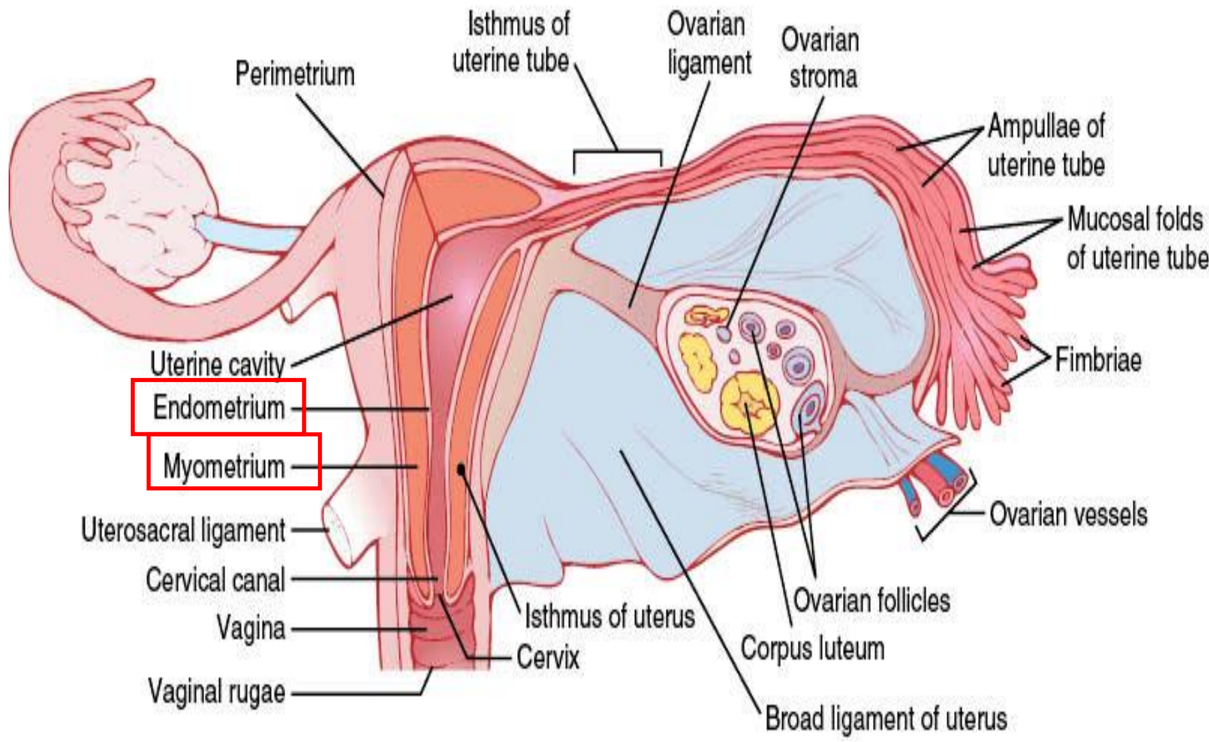
Cortex

Lined by the germinal epithelium

Glandular structures→ovarian F. at different stages

Medulla/zona vasculosa





(Redrawn from Guyton AC: Physiology of the Human Body, 6th ed. Philadelphia: Saunders College Publishing, 1984.)

Physiological anatomy of the female sexual organs

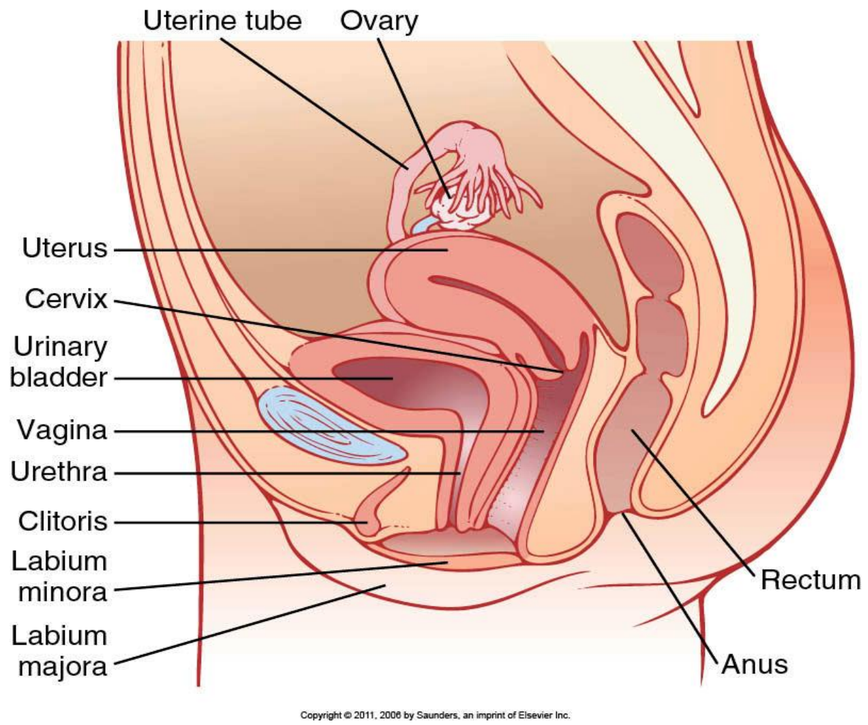
- **<u>Accessory sex organs</u>**

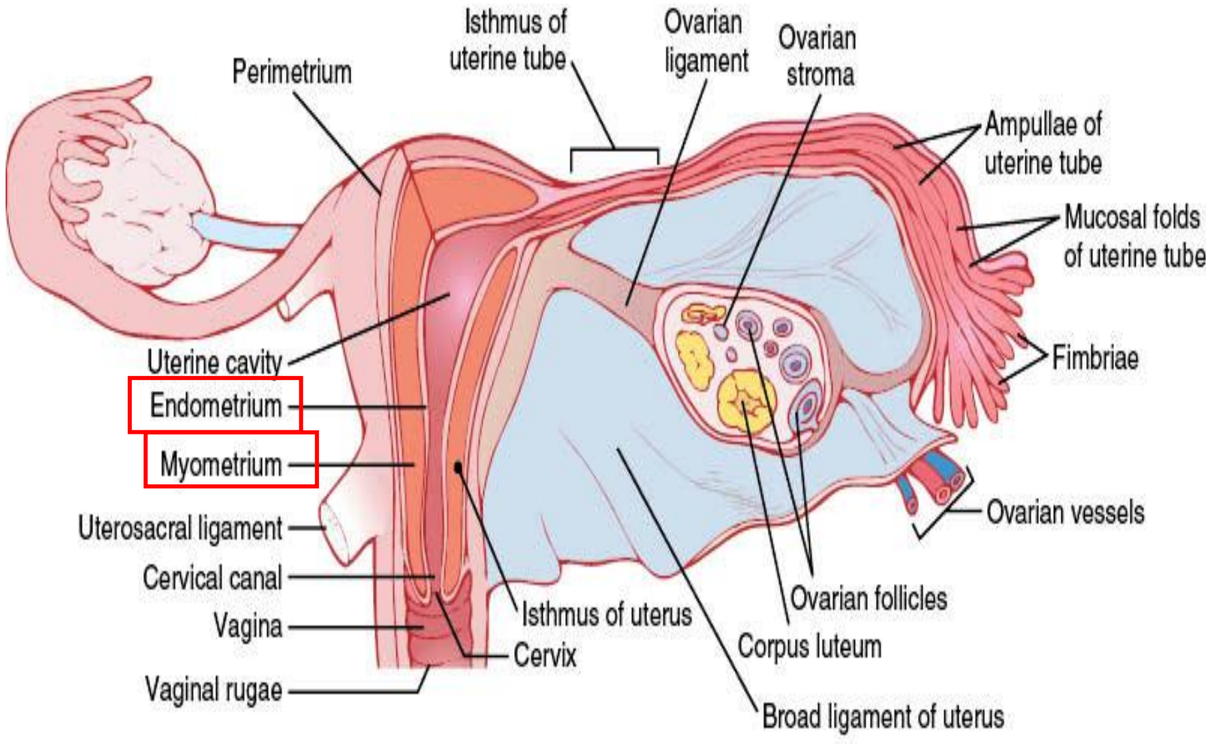
➢ Uterine/Fallopian tubes transport fertilized ova

➢ Uterus where fetal development occurs

➢ Cervix (mucus secretion), Vagina

➢ external genitalia constitute the vulva (L. majora, minora &clitoris)





(Redrawn from Guyton AC: Physiology of the Human Body, 6th ed. Philadelphia: Saunders College Publishing, 1984.)

Sexual life in females

FIRST PERIOD

- Birth-puberty
- primary and accessory sex organs do not function

SECOND PERIOD

- puberty -menopause
- First menstrual cycle = menarche
- Permanent stoppage of menstrual cycle=menopause (45 -50y).
- women menstruate and reproduce.

THIRD PERIOD

- Menopause-rest of life.

Oogenesis and follicular development in the ovaries

Intrauterine life

- germinal ridges→ germinal epithelium (cortex of ovary)→ primordial ova/oogonia
- Oogonia divide to produce millions by mitosis but most degenerate (atresia) during fetal growth
- Some develop into primary oocytes & stop in prophase stage of meiosis I
- 2 million present at birth
- 300, 000 remain at puberty but only 400- 500 mature during a woman's life
- Each month, hormones cause meiosis I to resume in several follicles so that meiosis II is reached by ovulation
- Penetration by the sperm causes the final stages of meiosis to occur

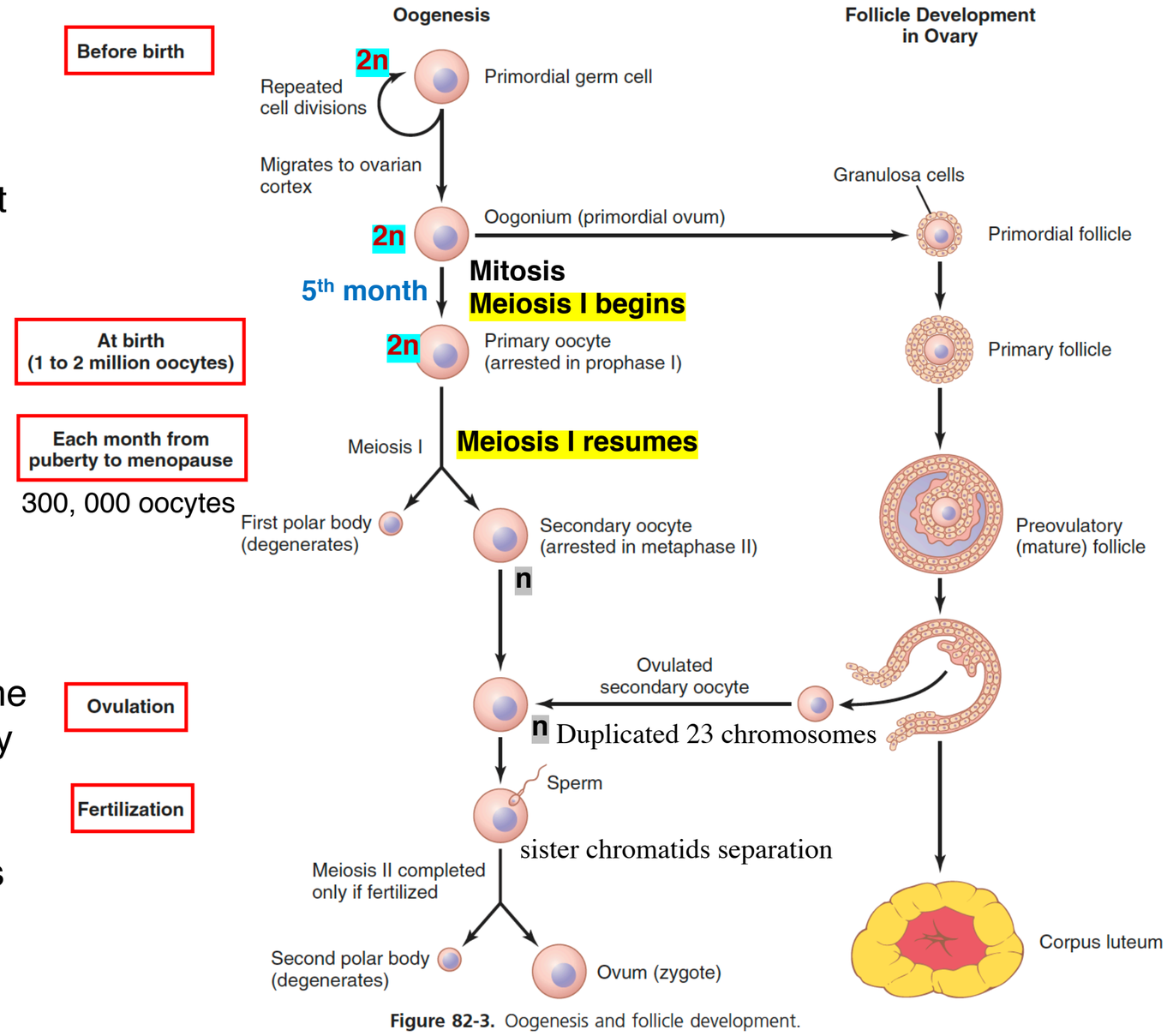


Figure 82-3. Oogenesis and follicle development.

Fundamental reproductive unit = single ovarian follicle=one germ cell (oocyte)+ surrounded by endocrine cells

Monthly ovarian cycle; function of the gonadotropic hormones

- **<u>female monthly sexual cycle /menstrual cycle= monthly rhythmical</u>**

  changes in:

  ✓rates of secretion of the female hormones

  ✓ovaries and other sexual organs.

  Avg 28 d (20-45 d)

  Abnormal cycle length→decreased fertility

- **<u>Outcomes of female sexual cycles:</u>**

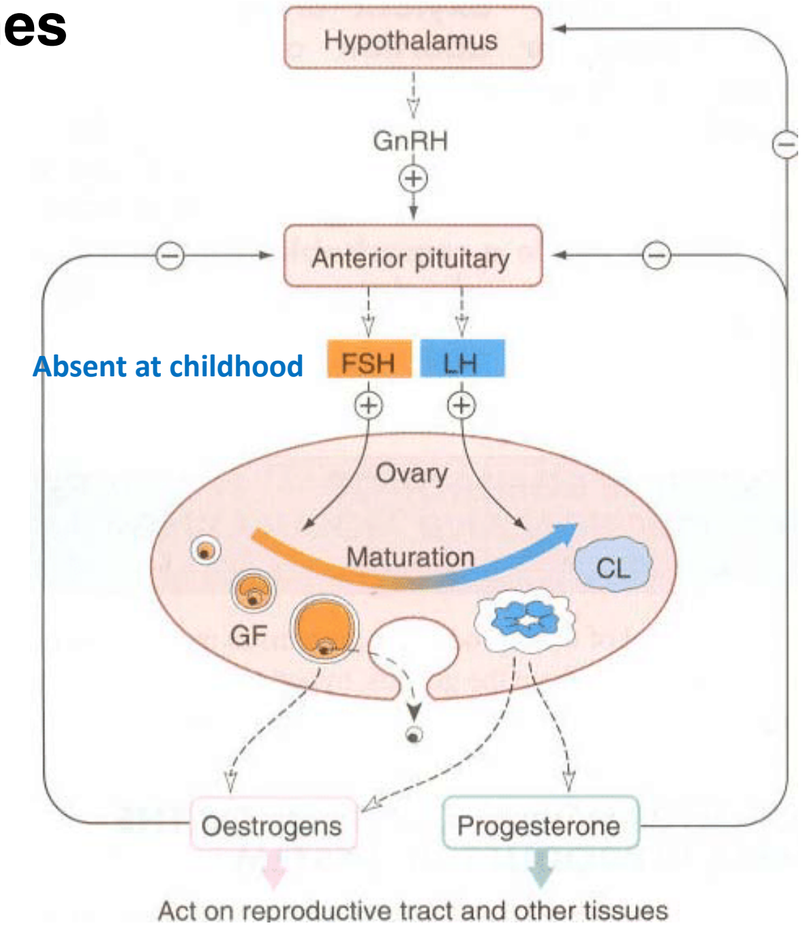
  1-single ovum/month→ fetus?

  2-prepared uterus for implantation

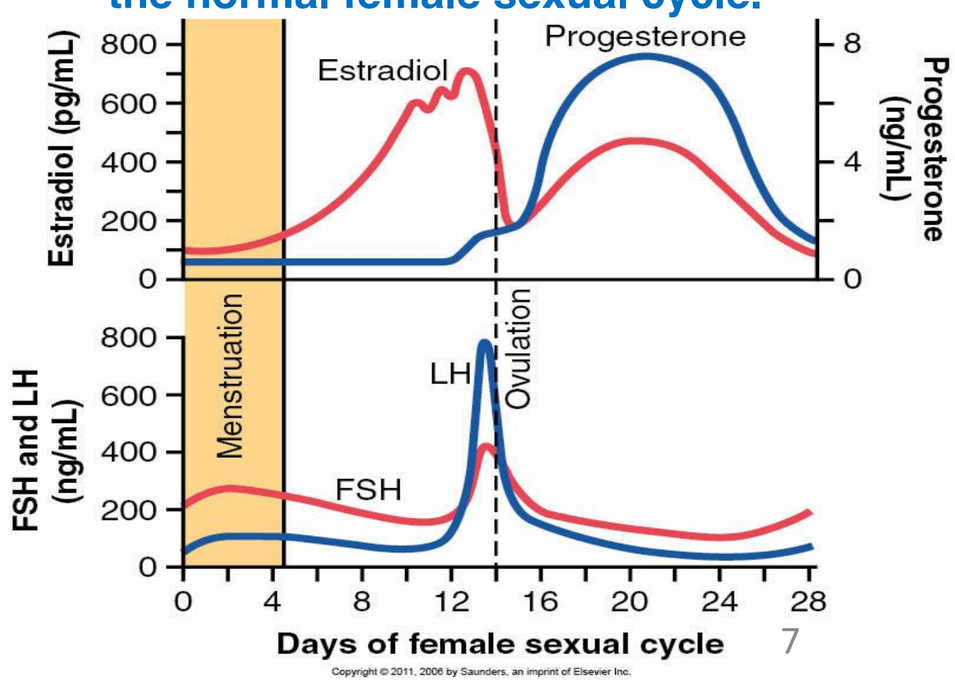
Monthly ovarian cycle; function of the gonadotropic hormones

- Ovarian function **<u>is completely dependent</u>** on FSH & LH
- 9 to 12 years→pituitary begins to secrete progressively more FSH and LH→ onset of monthly sexual cycles →beginning between the ages of 11 and 15 years (puberty)
- FSH & LH→ activate receptors in ovarian target cell → increase cells' rates of secretion+growth and proliferation of cells

- activation of cAMP→formation of protein kinases→ phosphorylations enzymes → stimulate sex hormone synthesis

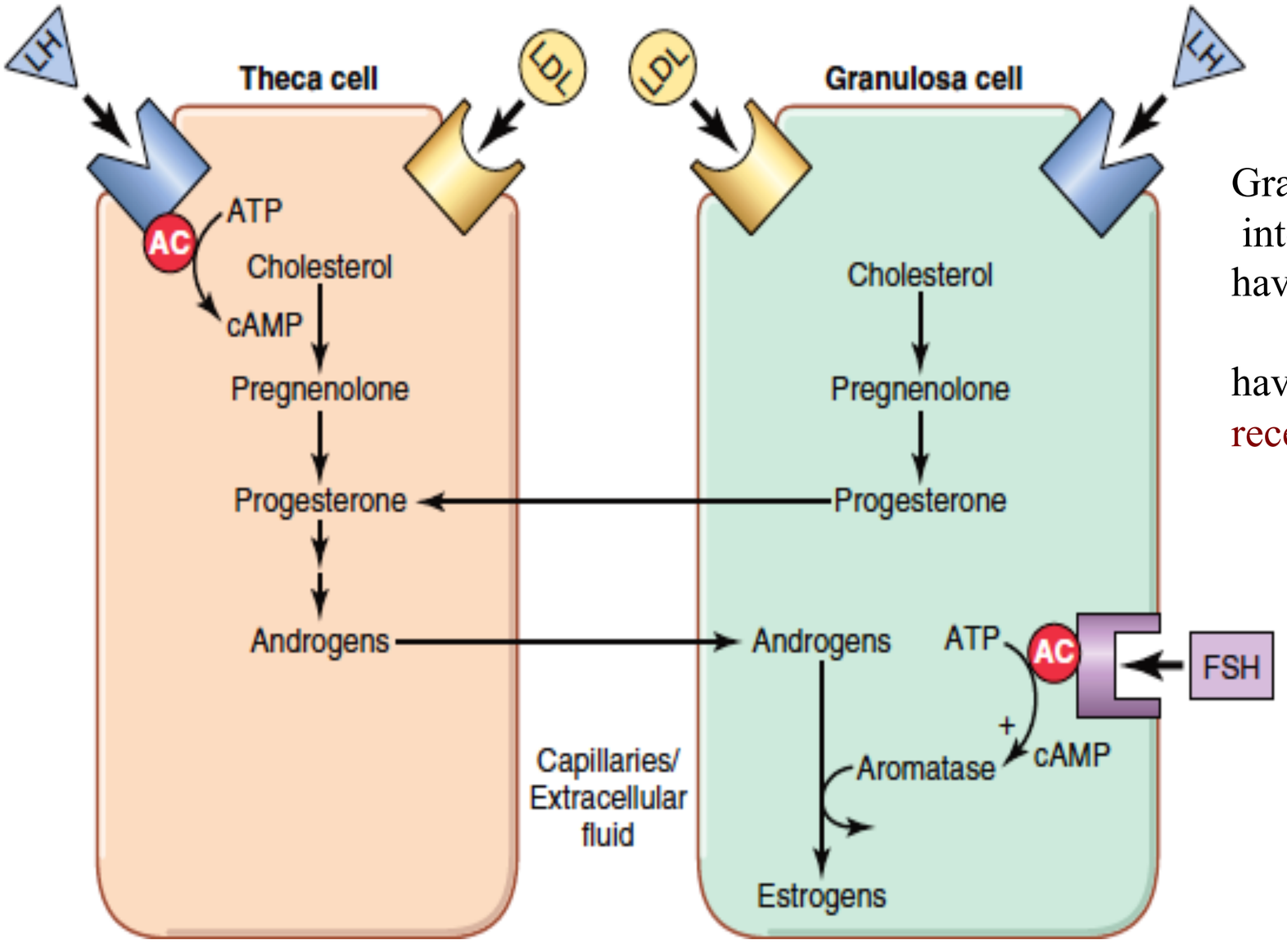


Female hormonal changes during the normal female sexual cycle.



Synthesis of estrogen by ovarian cells during menstrual cycle

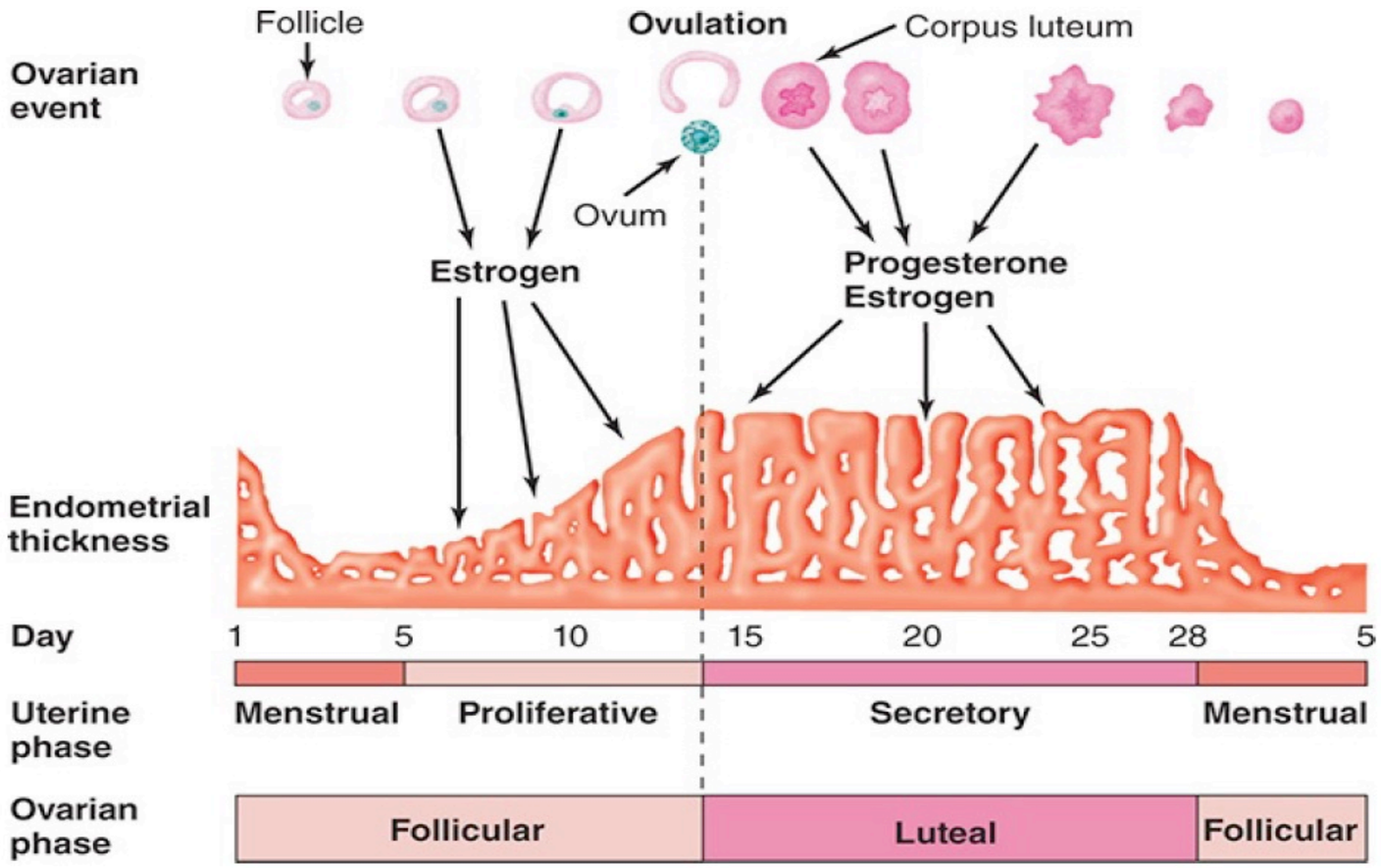
Thecal cells – superficial
no aromatase
have only LH Receptors
can get cholesterol from LDL in blood



Granulosa cells
interior
have aromatase

have both LH and FSH receptors

Female monthly sexual cycle



Ovarian cycle—
follicular phase -- avg 15 d (range, 9-23 days)
ovulatory phase -- 1-3 d -- culminates with ovulation
luteal phase – 13 d -- less variable than follicular

Endometrial cycle -- menstruation, proliferative and secretory phases

Female monthly sexual cycle

Enlargement of the ovum
Growth of additional layers of granulosa cells

single layer of granulosa cells

Functions of granulosa cells:

Nourishment

Secretion of oocyte maturation inhibiting factor

↓

prophase

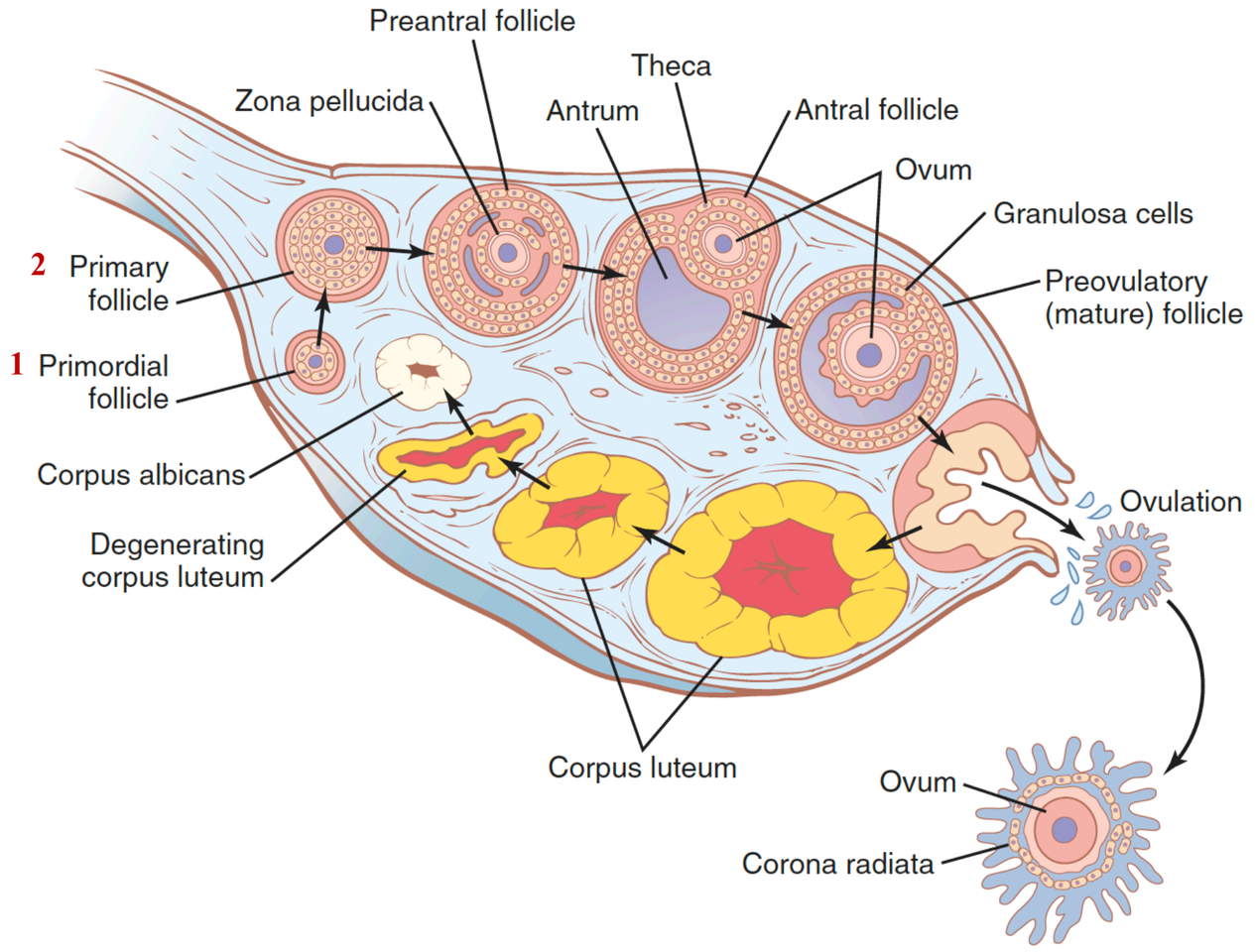
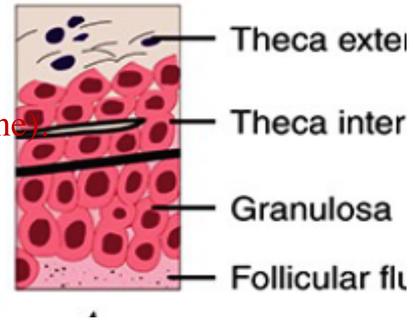


Figure 82-5. Stages of follicular growth in the ovary, also showing formation of the corpus luteum.

3 FSH & LH →increase slightly to moderately increase in FSH slightly greater than that of LH and preceding it by a few days.
These hormones(especially **FSH)** → cause **accelerated growth** of 6-12 primary follicles/month
The initial effect is **rapid proliferation** of the granulosa cells→ many more layers
Formation of theca cells

capsule

(estrogen & progesterone)



FSH→granulosa cells→ secretes a follicular fluid containing high concentration of estrogen

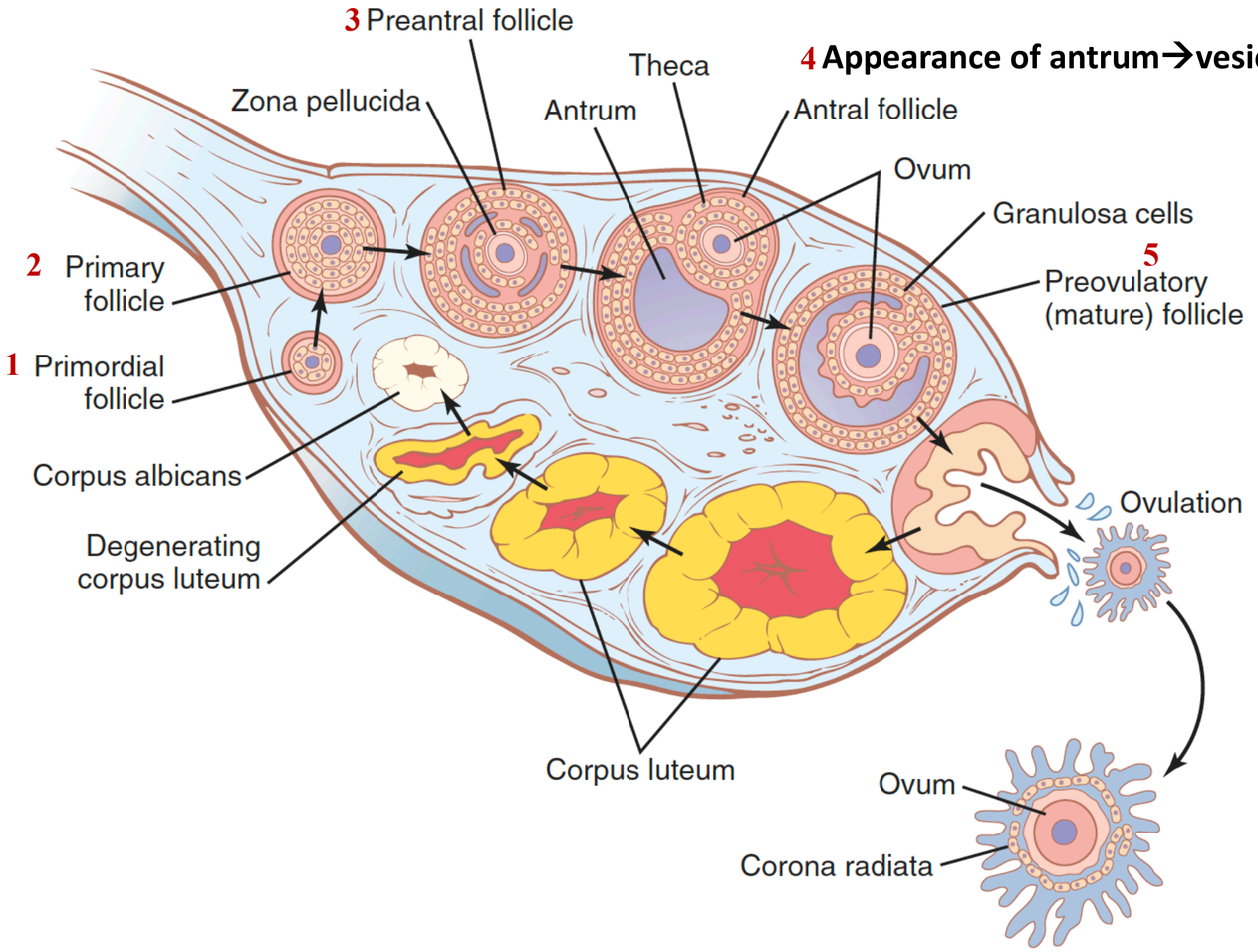


Figure 82-5. Stages of follicular growth in the ovary, also showing formation of the corpus luteum.

<u>accelerated growth is caused by:</u>

1. ***<u>Estrogen</u>*** is secreted into follicle and causes the **<u>granulosa</u>** cells to form increasing numbers of FSH Receptors→positive feedback effect (makes the granulosa cells even more sensitive to FSH (intrinsic +ve FB)

2. FSH & estrogens combine to promote **LH receptors** on **<u>granulosa</u>** cells, thus allowing LH stimulation to occur in addition to FSH stimulation and creating an even more rapid increase in **follicular secretion.**

3. The increasing estrogens from follicle +↑LH act together to cause proliferation of the follicular **thecal** cells and increase their **secretion** as well.

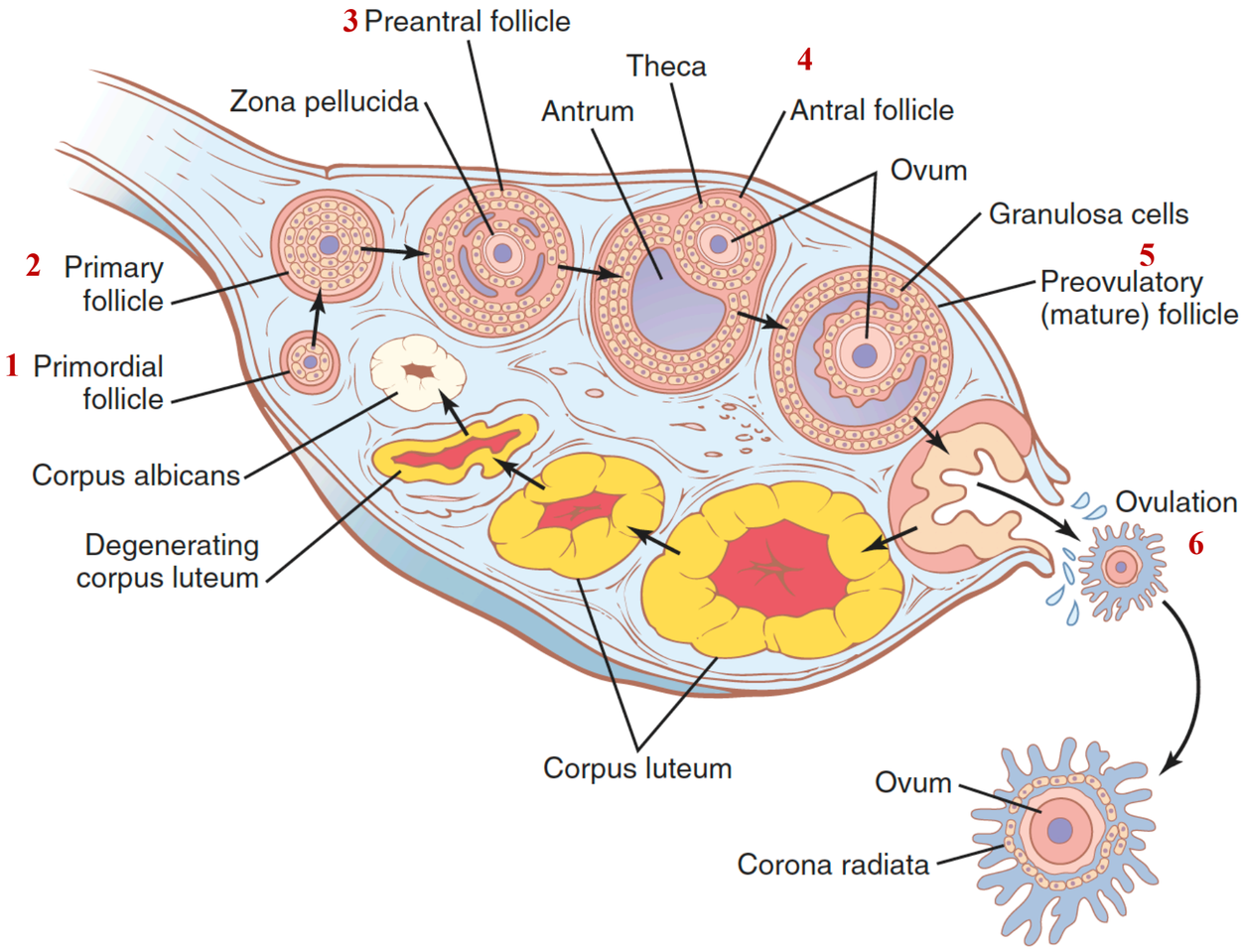


Figure 82-5. Stages of follicular growth in the ovary, also showing formation of the corpus luteum.

Only **One** Follicle Fully Matures (**outgrow** all the others) Each Month, and the Remainder Undergo Atresia→1 fetus/preg

cause → large amounts of estrogen from the most rapidly growing follicle →hypothalamus→inhibit FSH → blocking further growth of the less well-developed follicles.

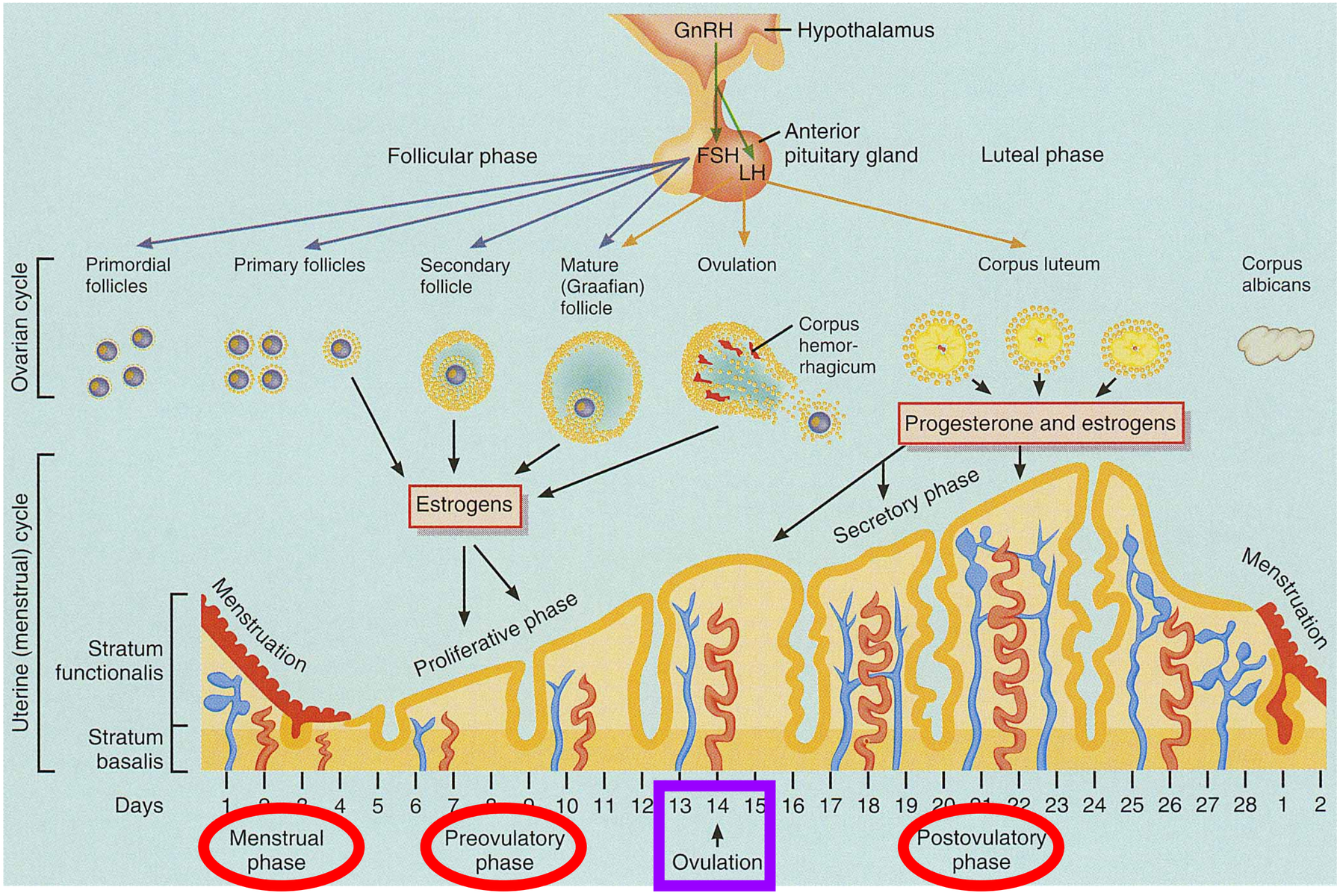
the largest follicle continues to grow because of its intrinsic positive feedback effects

The single follicle reaches a diameter of 1-1.5 centimeters at the time of ovulation and is called the **mature follicle**.

In the uterus (proliferative phase)

increasing estrogen levels re-epithelialize endometrial surface within 4 to 7 days after the beginning of menstruation

After that→increase numbers of stromal cells & progressive growth of the endometrial glands and new blood vessels



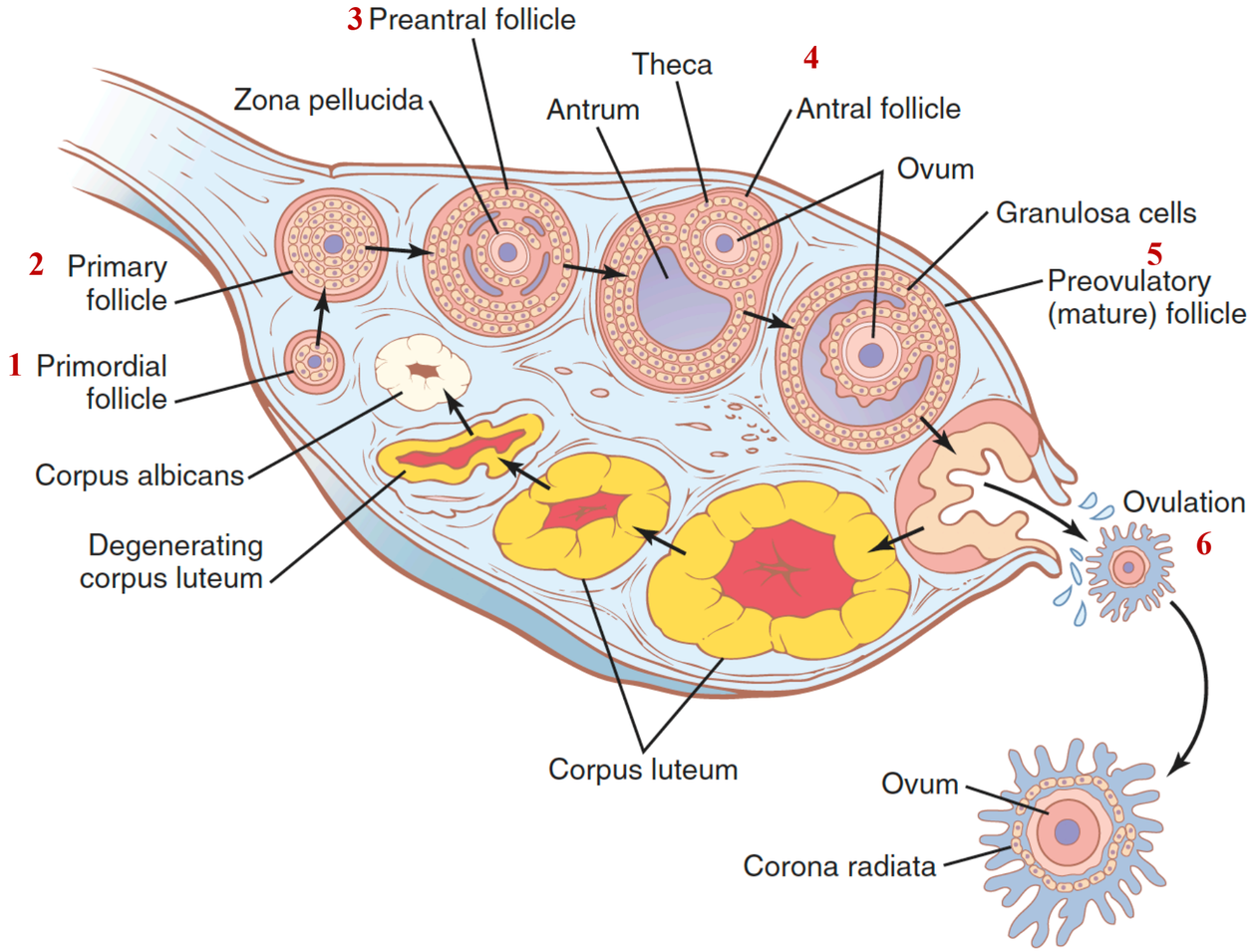


Figure 82-5. Stages of follicular growth in the ovary, also showing formation of the corpus luteum.

6-Ovulation

In 28-day cycle →ovulation 14 days after onset of menstruation small area in the center of the follicular capsule (**stigma**)→ ruptures →ovum surrounded by a granulosa cells→called the corona radiata

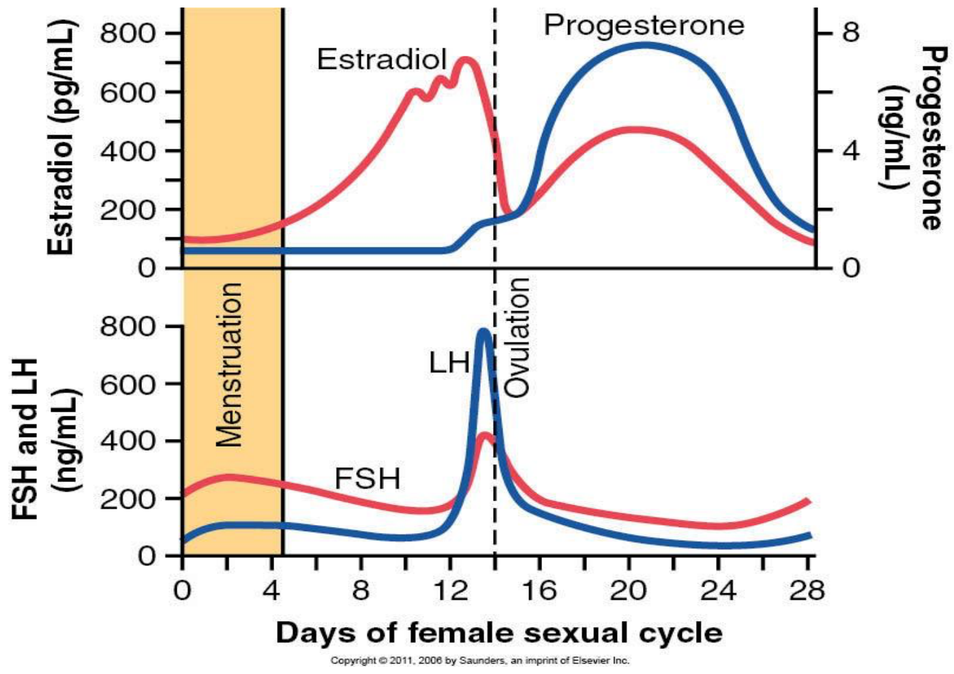
Ovulation

- A Surge of LH Is Necessary for Ovulation.
- **LH** is necessary for **final** *follicular growth* and ovulation.

- **2 days** before ovulation → rate of secretion of LH **increases markedly**, 6-10-fold, peaking 16h before ovulation.

- **FSH** also increases 2-3 fold at the same time

- FSH & LH act synergistically to cause rapid swelling of the follicle before ovulation.



- LH converts **granulosa and theca** cells to mainly **progesterone** secreting cells.

- rate of secretion of estrogen begins to fall about **1 day before ovulation**

Signs of Ovulation

- Increase in basal body temperature
- Changes in cervical mucus
- Cervix softens
- Mittelschmerz---pain

Postovulatory Phase

- lasts 14 days
- In the ovary→ (luteal phase)
  - LH→luteinization→granulosa & theca interna cells change rapidly into **lutein** cells→filled with lipid→c. luteum→P&E→low FSH&LH
  - Lutein cells→inhibin→inhibt FSH

↓

Involution of CL

- No fertilization→corpus albicans is formed
  - as hormone levels drop, secretion of GnRH, FSH & LH rise

- if fertilization did occur, developing embryo secretes human chorionic gonadotropin (hCG) which maintains health of corpus luteum & its hormone secretions

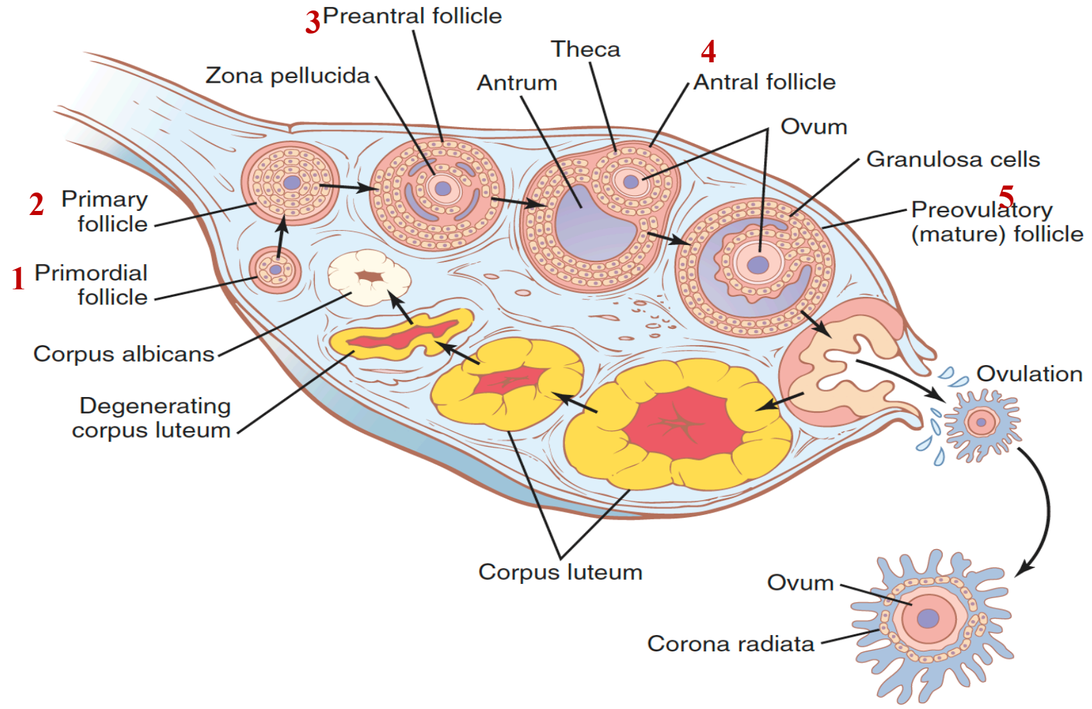
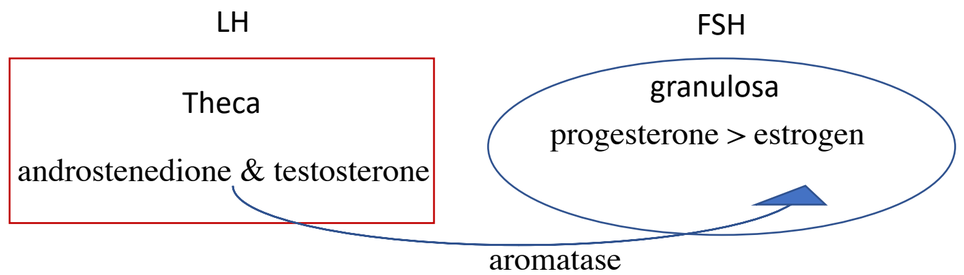
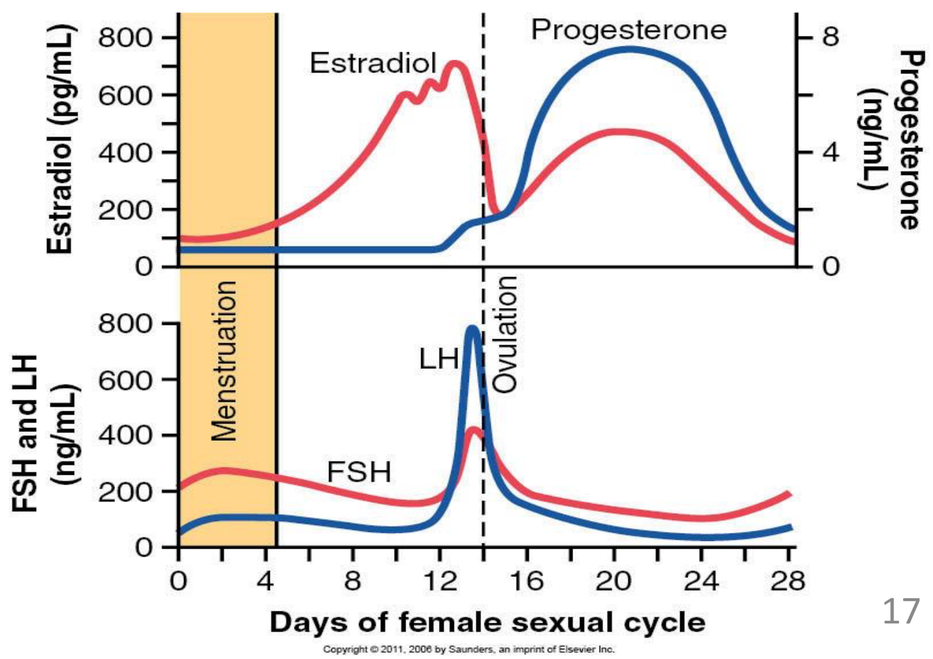


Figure 82-5. Stages of follicular growth in the ovary, also showing formation of the corpus luteum.





Postovulatory Phase

- In the uterus (secretory phase/progstational phase)
  - Hormones (progesterone mainly) from corpus luteum promote marked swelling and secretory development of **endometrium**→provide appropriate conditions for implantation of a fertilized ovum

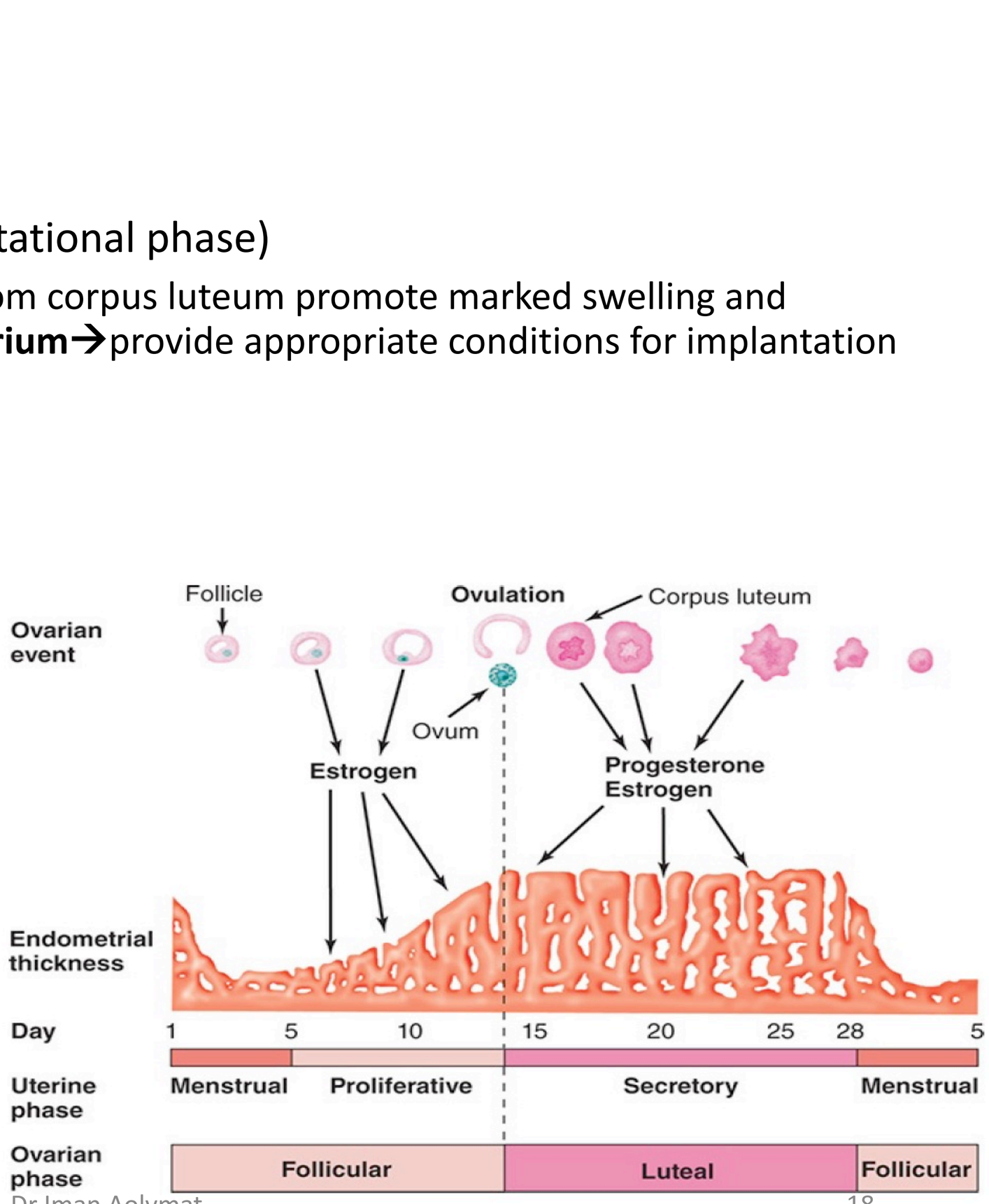
Glands→
increase in tortuosity
excess of secretory substances accumulates in the glandular epithelial cells

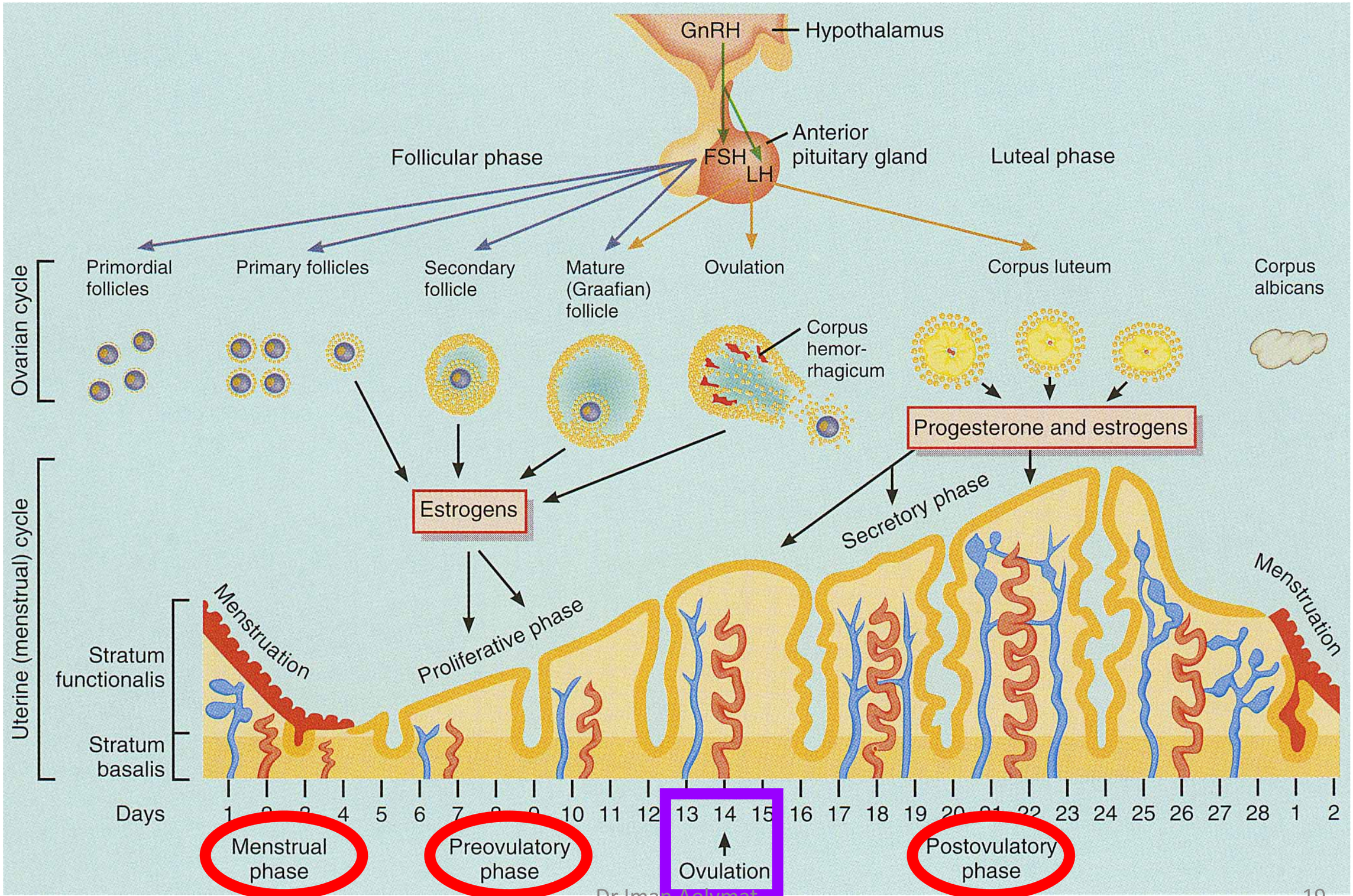
stromal cells →
Cytoplasm increases
lipid and glycogen depositsiton

Increase blood supply to the endometrium
→blood vessels
becoming highly tortuous.

“uterine milk,” provide nutrition for the early dividing ovum

if no fertilization occurs, menstrual phase will begin




GnRH
Hypothalamus
Anterior pituitary gland
FSH
LH
Follicular phase
Luteal phase
Ovarian cycle
Primordial follicles
Primary follicles
Secondary follicle
Mature (Graafian) follicle
Ovulation
Corpus luteum
Corpus albicans
Corpus hemor-rhagicum
Progesterone and estrogens
Estrogens
Secretory phase
Proliferative phase
Menstruation
Menstruation
Uterine (menstrual) cycle
Stratum functionalis
Stratum basalis
Days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 1 2
Menstrual phase
Preovulatory phase
Ovulation
Postovulatory phase

Menstrual Phase

- Menstruation lasts for 5 days
- First day is considered beginning of 28 day cycle
- In ovary
    - Early follicular growth
- In uterus
    - declining levels of progesterone (mainly) & estrogen
    - caused spiral arteries to constrict – ischemia & necrosis→glandular tissue dies
    - stratum functionalis layer is sloughed off along with 40 ml of blood, 35 ml serous fluid
    - The menstrual fluid is **nonclotting**→because a fibrinolysin is released along with the necrotic endometrial material. excessive bleeding→ not enough fibrinolysin →clotting
    - Within 4 to 7 days after menstruation starts, the loss of blood ceases because, by this time, the endometrium has become **re-epithelialized.**

The end