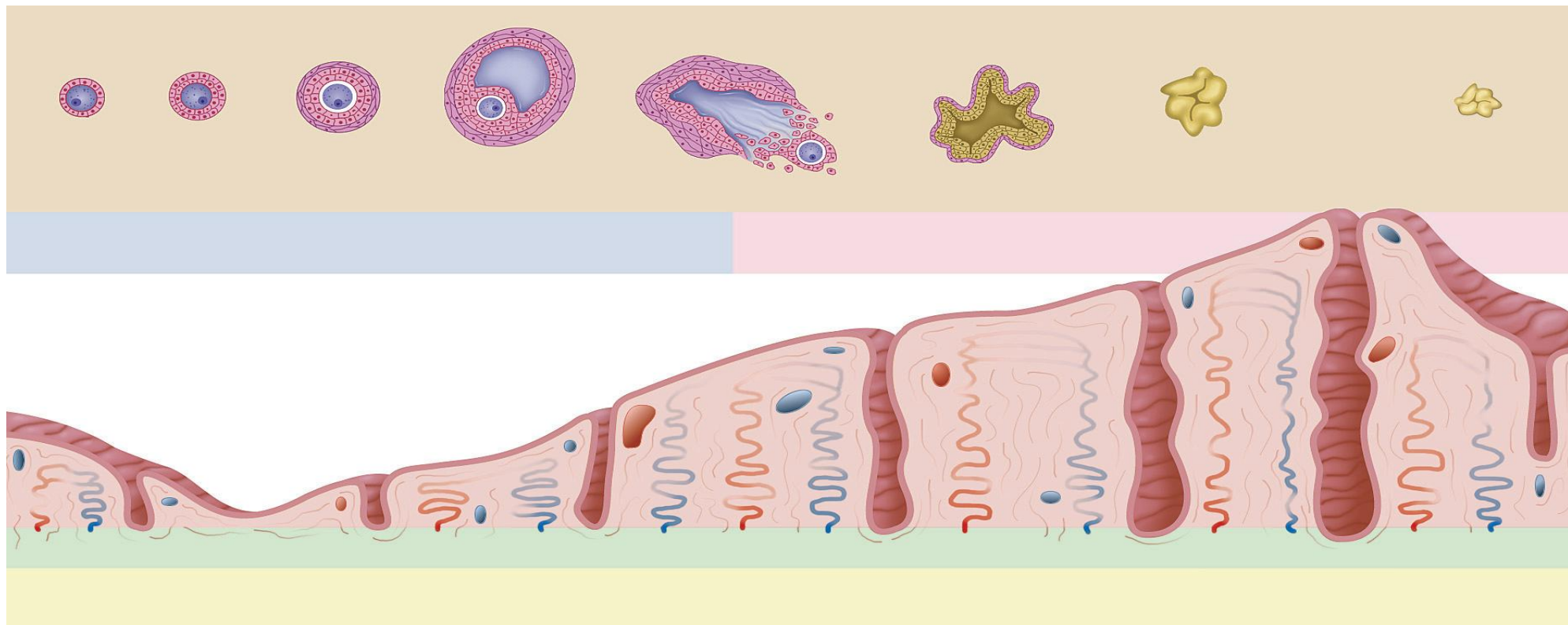




# Female Reproductive (Menstrual) Cycle

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*Prepared and adapted for teaching by Prof. Dr. Heba Kalbouneh.  
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**The ovarian cycle**

**The uterine (endometrial) cycle**

## Learning Objectives

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

1. Describe the phases of the ovarian and uterine cycles.
2. Correlate ovarian changes with uterine (endometrial) changes.
3. Explain hormonal regulation of the cycle (FSH, LH, estrogen, progesterone).
4. Explain what happens with and without pregnancy.
5. Apply the knowledge clinically (luteal phase defect, anovulation, hormonal contraception).

# Female Reproductive Cycle= Female Menstrual Cycle

*Menstrual means Monthly*

## Ovarian cycle

1. Follicular Phase (Day 1–14)
2. Ovulation (≈ Day 14)
3. Luteal Phase (Day 14–28)

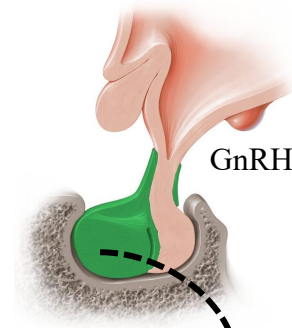
## Uterine cycle

1. Menstrual Phase (Day 1–5)
2. Proliferative Phase (Day 6–14)
3. Secretory Phase (Day 15–28)

**Normal cycle length:** 21–35 days  
**Polymenorrhea:** < 21 days  
**Oligomenorrhea:** > 35 days

## Overview of the Female Reproductive Cycle

- Average cycle length: **28 days** (normal range 21–35 days)
- Day 1 = first day of menstruation
- Controlled by the **Hypothalamic–Pituitary–Ovarian (HPO) axis**

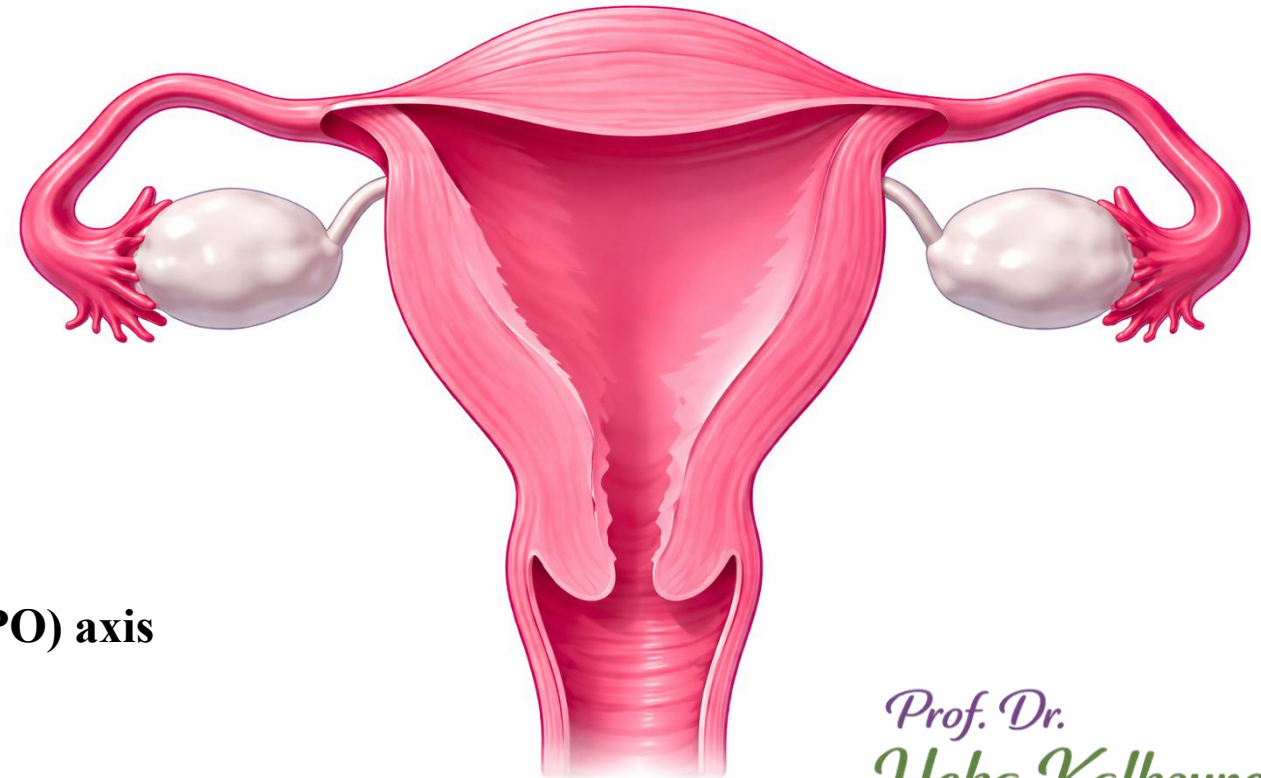
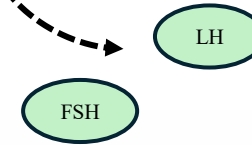


### Hormonal Axis

Hypothalamus → **GnRH**

Anterior pituitary → **FSH & LH**

Ovary → **Estrogen & Progesterone**



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# The Ovarian Cycle

Divided into three phases:

## A. Follicular Phase (Day 1–14)

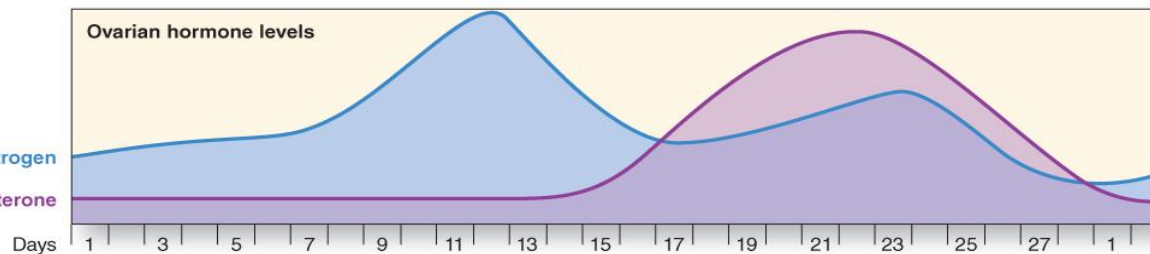
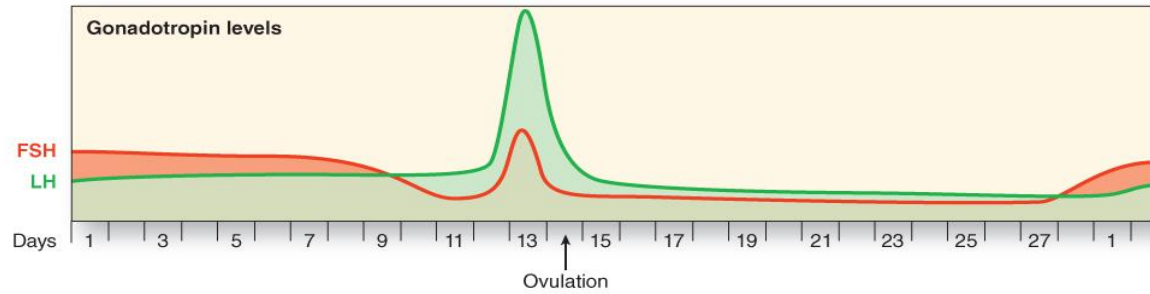
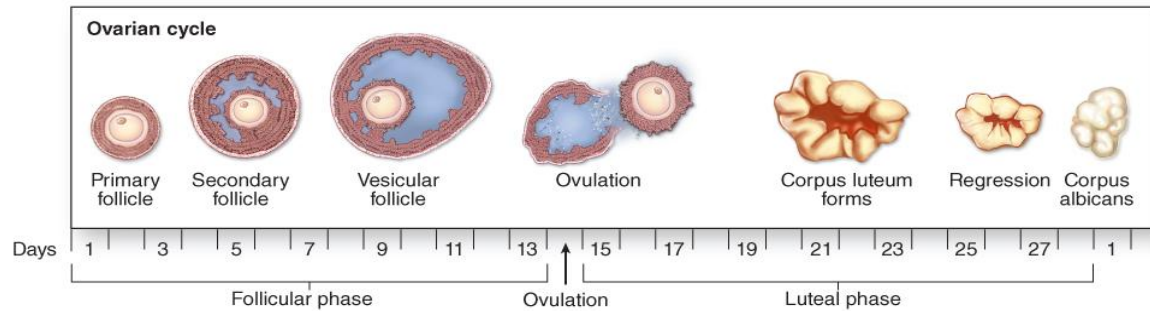
- ✓ Begins with menstruation
- ✓ FSH stimulates follicular growth

## What happens in ovary?

- Primordial follicles → Primary → Secondary → Graafian follicle
- LH stimulates theca cells → androgens
- FSH stimulates granulosa cells → convert androgens to estrogen

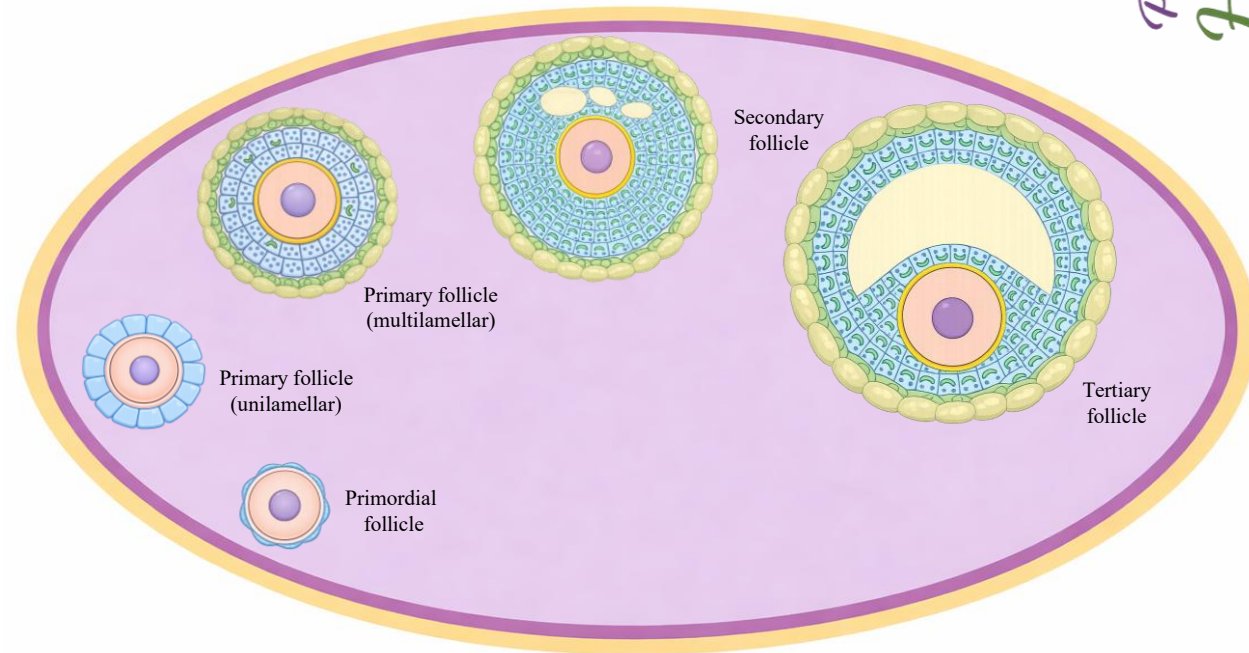
## Hormone pattern:

- Estrogen gradually increases
- Progesterone remains low



*LH → Theca cells → Androgens*

*FSH → Granulosa cells → Estrogen*



## B. Ovulation (Around Day 14)

Triggered by:

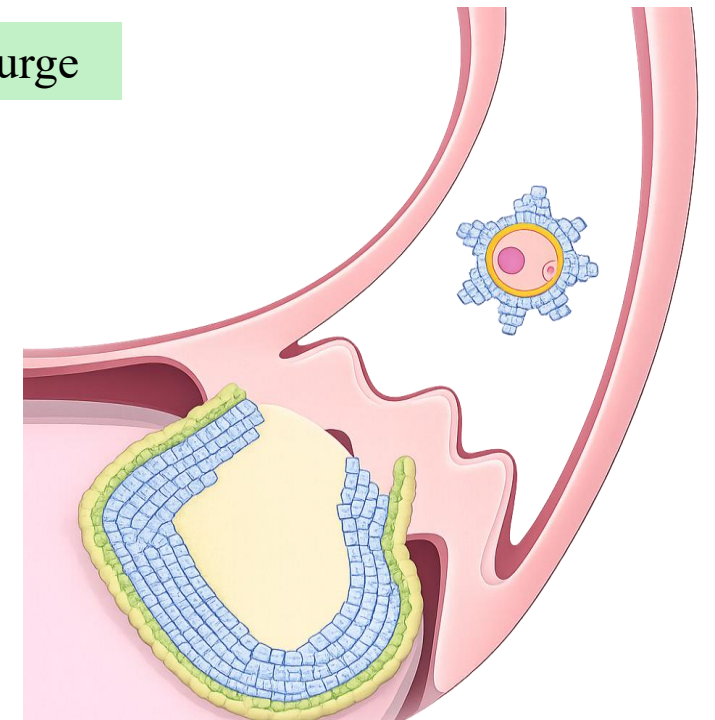
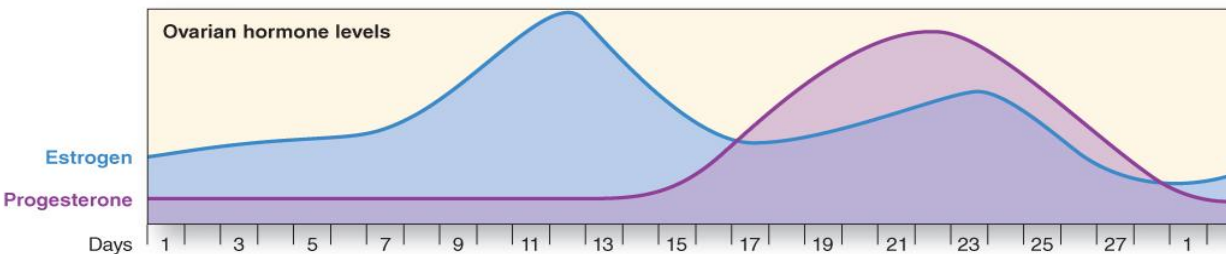
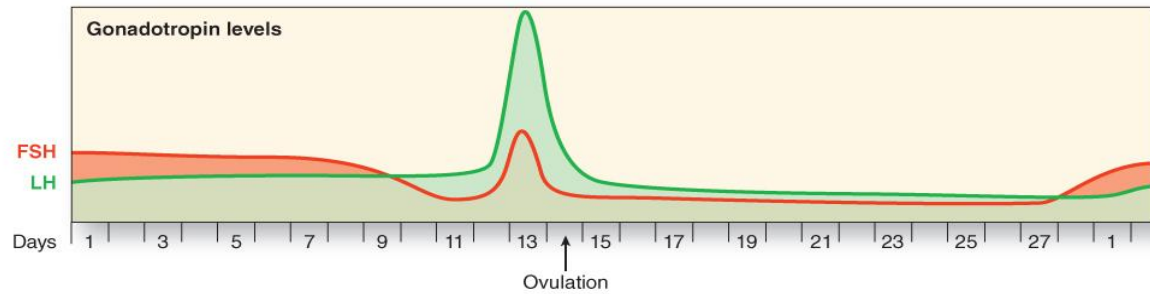
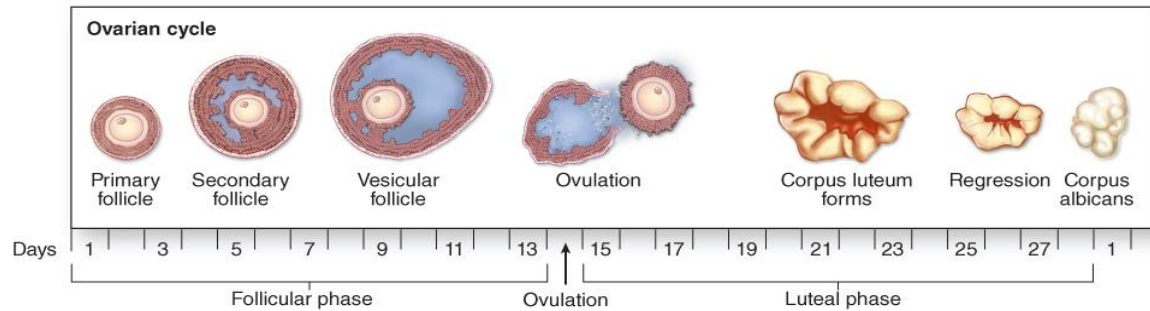
→ LH surge

Result:

- Graafian follicle ruptures
- Secondary oocyte released (metaphase II arrest)

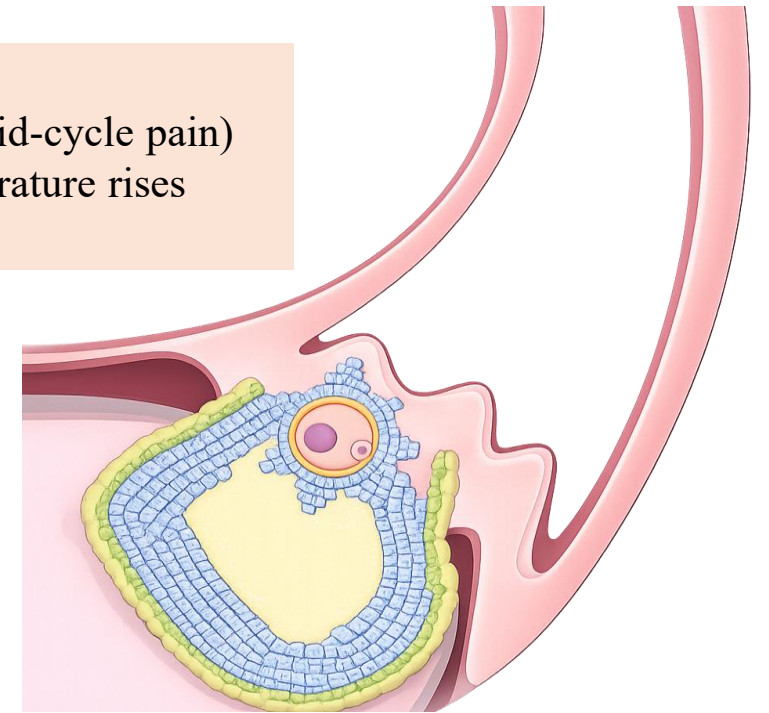
Sustained high estrogen → Positive feedback → LH surge

*Note: Low to moderate levels of estrogen exert negative feedback on FSH and LH secretion, whereas sustained high levels of estrogen exert positive feedback, leading to increased LH (and to a lesser extent FSH) secretion.*



### Clinical correlation:

- Mittelschmerz (mid-cycle pain)
- Basal body temperature rises AFTER ovulation

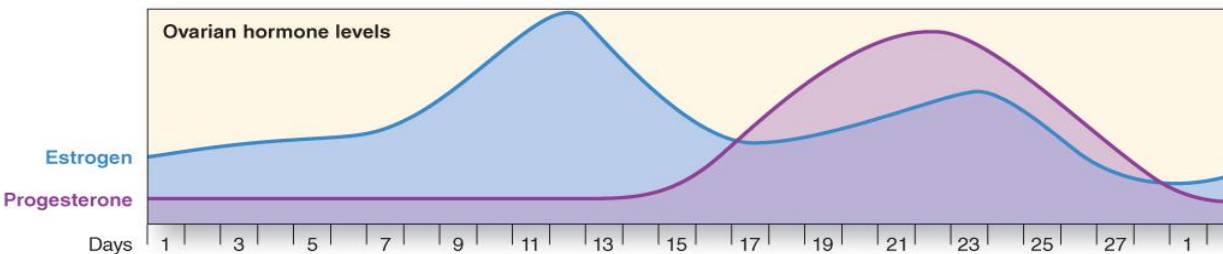
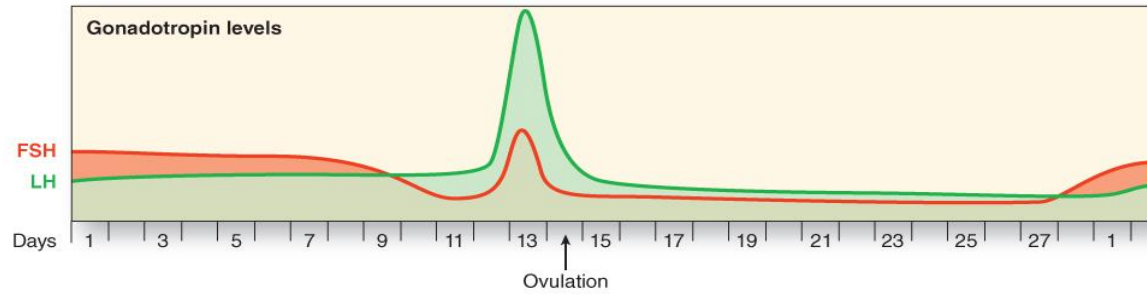
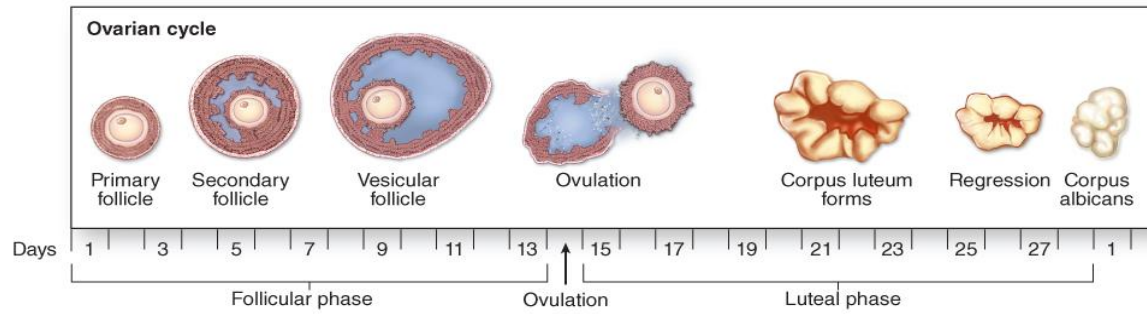


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## Luteal Phase (Day 14–28)

After ovulation:

- Follicle transforms into Corpus luteum
- Under LH stimulation
- Corpus luteum produces:
  - **Progesterone (main hormone)**
  - Estrogen

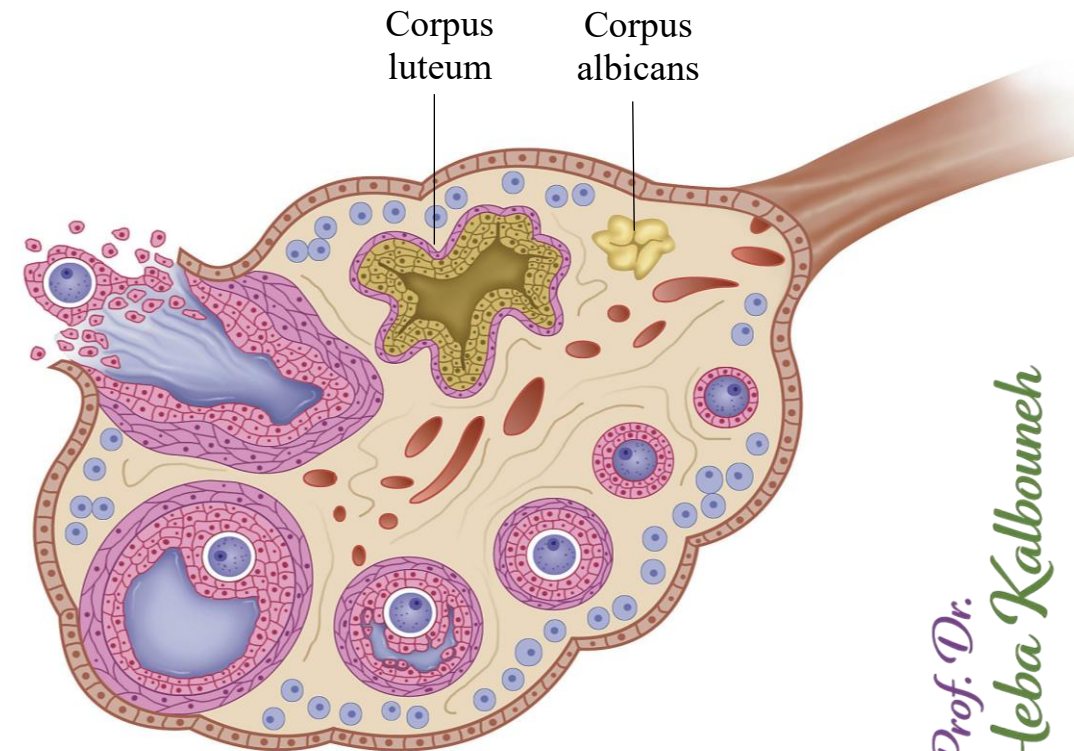


## Function:

- Prepare endometrium for implantation

## If no pregnancy:

- Corpus luteum lives ~ 10-14 days
- Corpus luteum regresses → Corpus albicans
- Progesterone falls
- Menstruation begins



# The Uterine (Endometrial) Cycle

Divided into three phases:

## A. Menstrual Phase (Day 1–5)

- Drop in progesterone
- Spiral artery constriction
- Functional layer sheds
- Bleeding lasts 3–5 days

## B. Proliferative Phase (Day 6–14)

Under **estrogen influence**

- Endometrium thickens
- Glands are straight
- Stroma proliferates
- Spiral arteries elongate

This corresponds to: **Ovarian follicular phase**

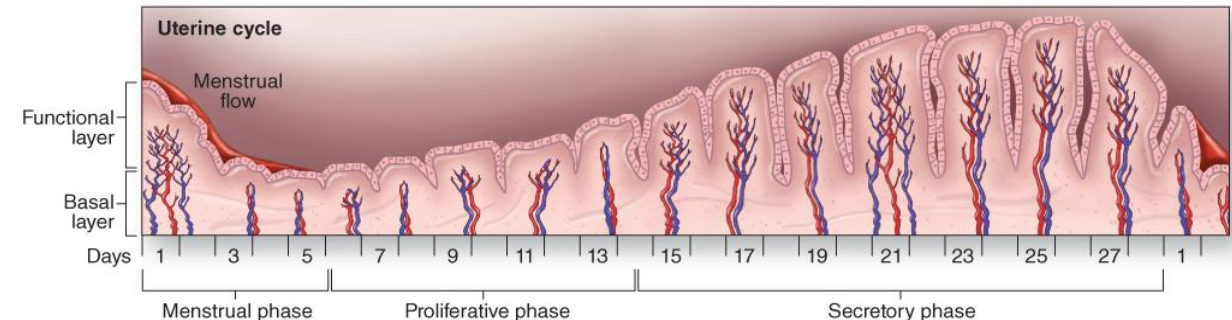
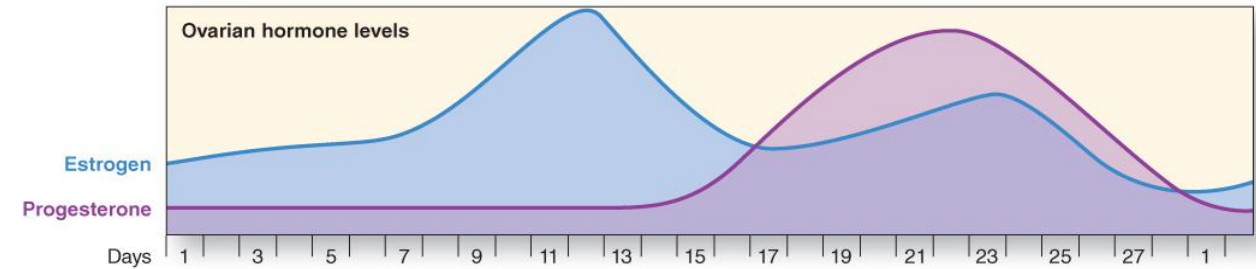
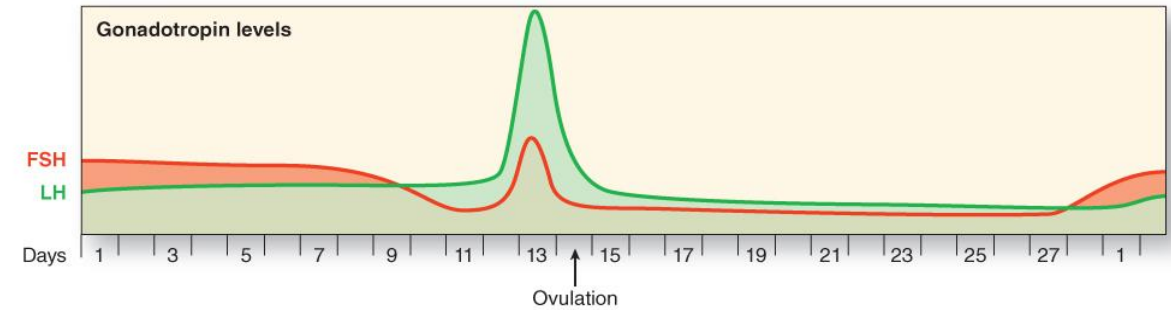
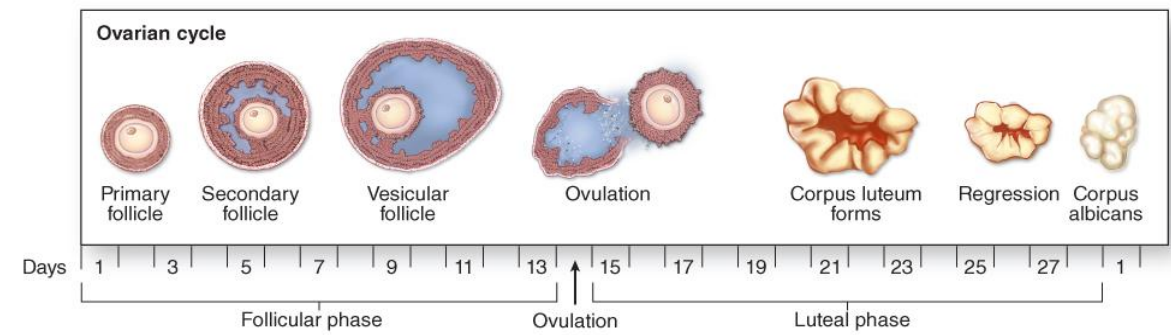
## C. Secretory Phase (Day 15–28)

Under **progesterone influence**

- Endometrium becomes edematous
- Glands become coiled
- Glycogen secretion increases
- Ideal for implantation

This corresponds to: **Ovarian luteal phase**

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## Hormonal Pattern Summary

### Follicular Phase

- FSH ↑ (early)
- Estrogen ↑ (gradually)
- LH low

### Ovulation

- LH surge
- Small FSH surge

### Luteal Phase

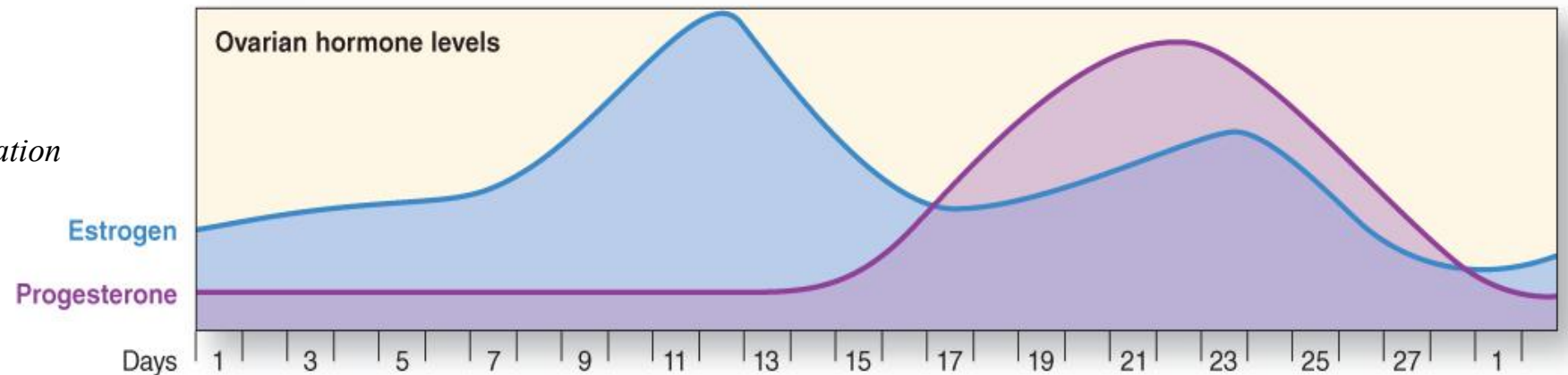
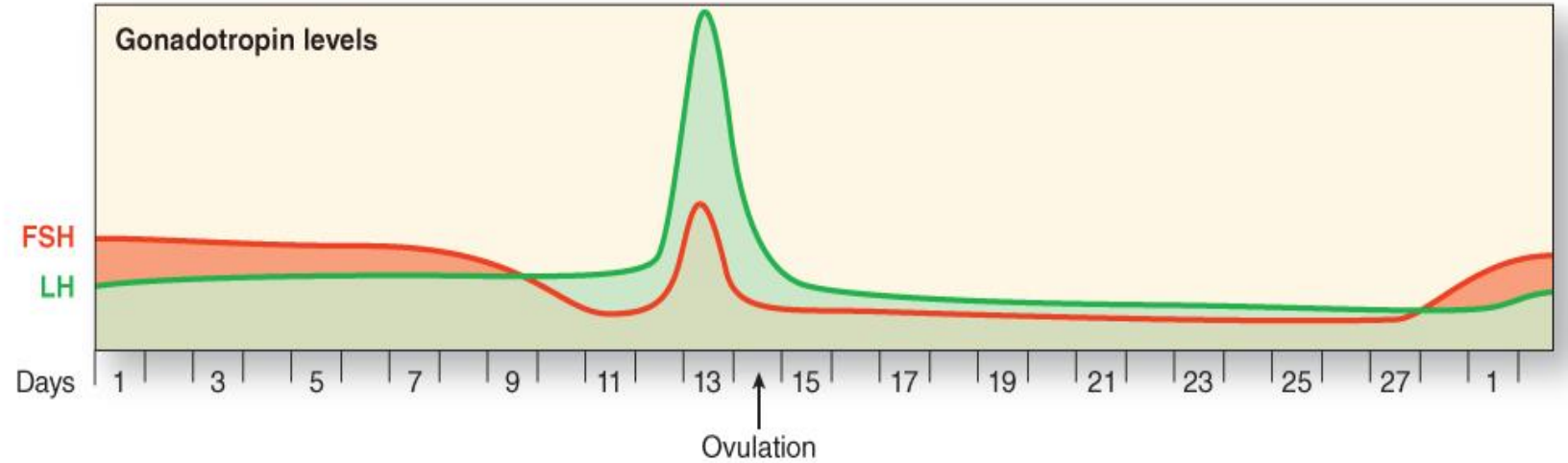
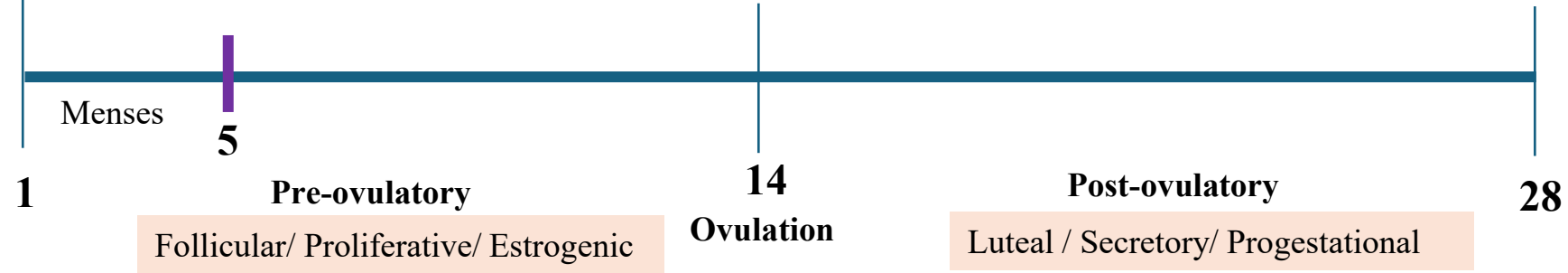
- Progesterone ↑↑
- Moderate estrogen
- FSH & LH suppressed

*FSH → Follicle growth → Estrogen ↑*

*Estrogen peak → LH surge → Ovulation*

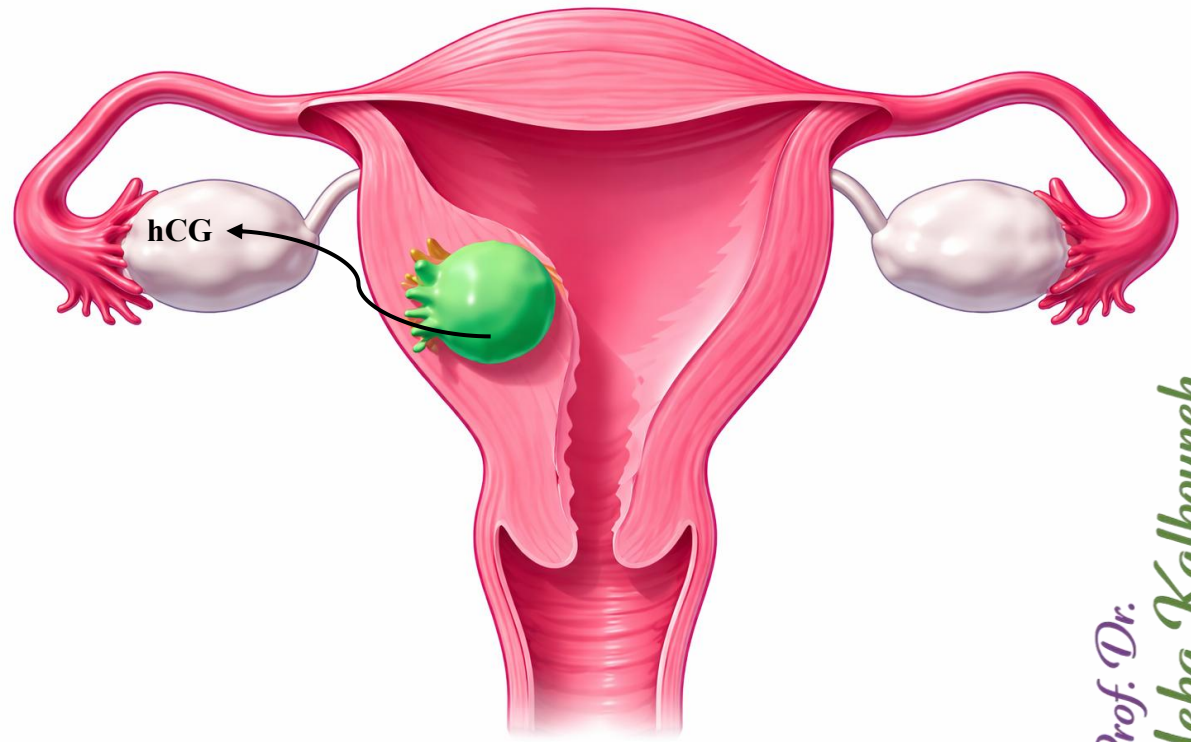
*LH → Corpus luteum → Progesterone ↑*

*No pregnancy → Progesterone ↓ → Menstruation*



# If Fertilization Occurs

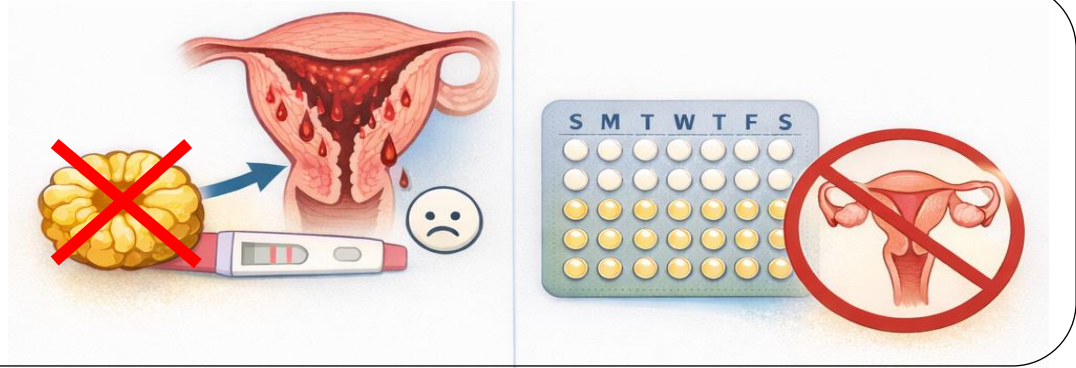
- Trophoblast secretes **hCG**
- hCG maintains corpus luteum → *Note: hCG is similar to LH*
  
- Progesterone remains high
- No menstruation
- Placenta takes over at ~12 weeks/ ~ 3 months



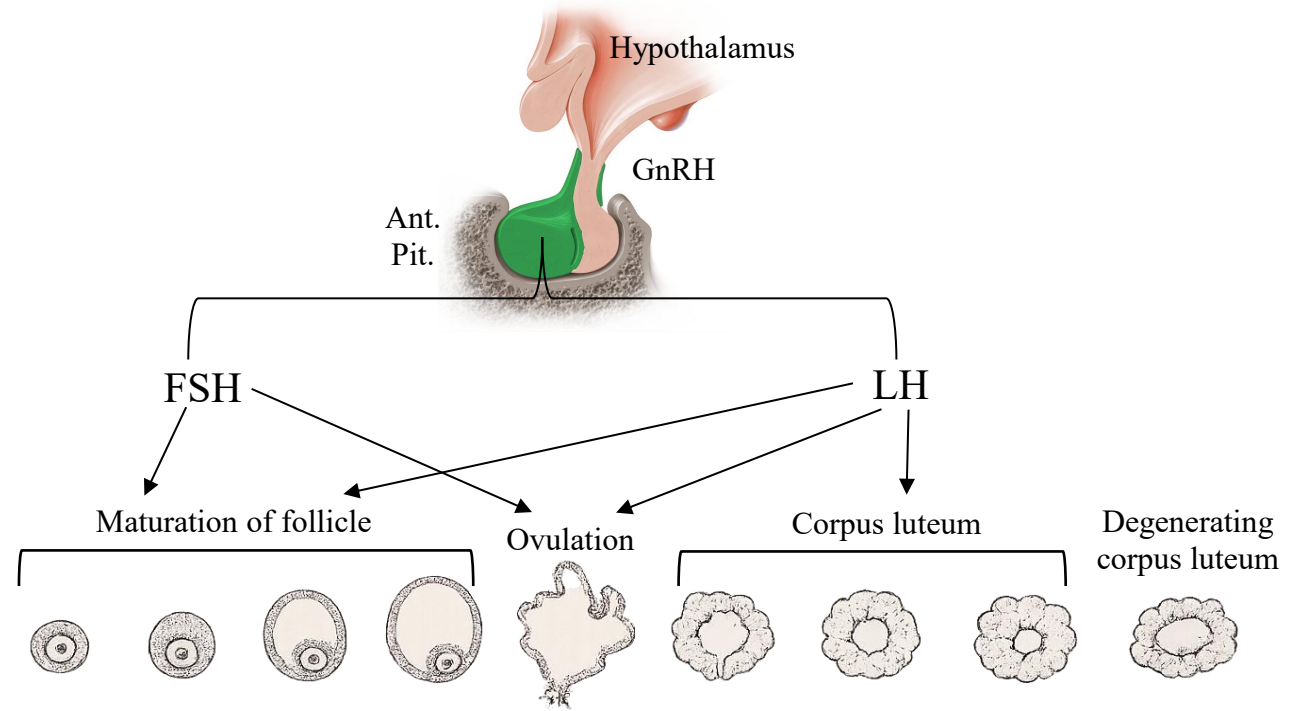
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# Clinical Correlations

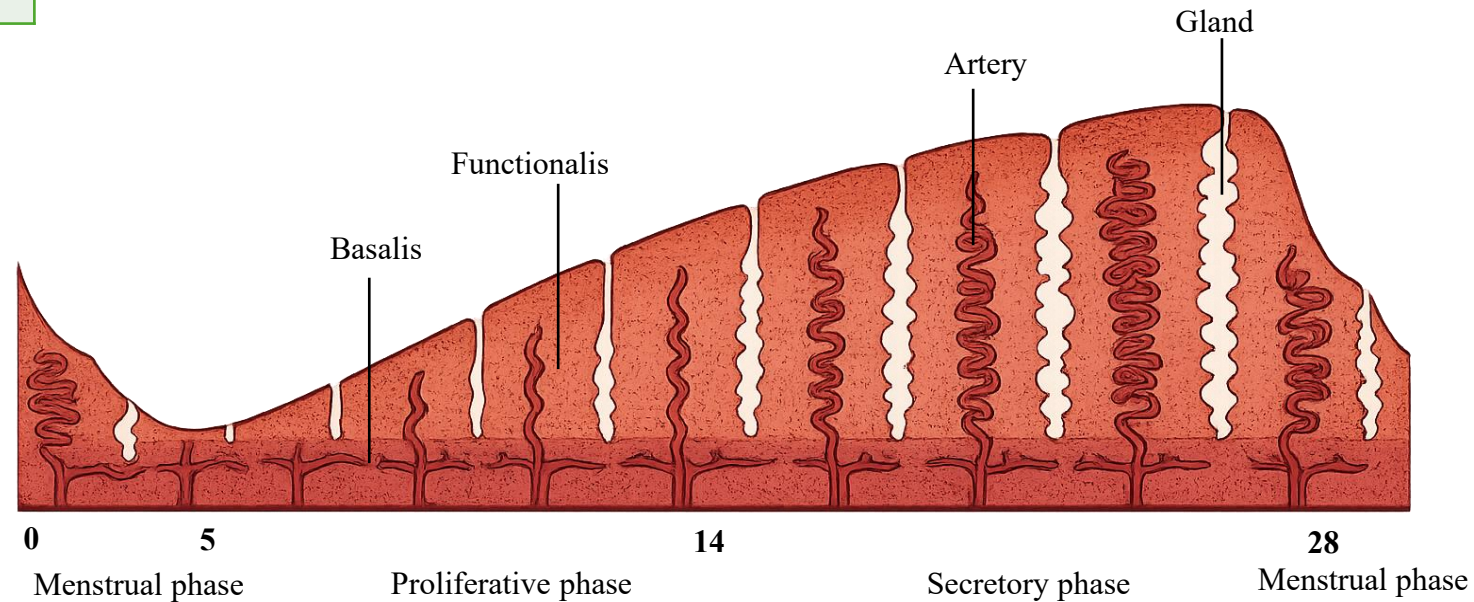
- Anovulatory cycles → no corpus luteum → irregular bleeding
- Luteal phase defect → low progesterone → infertility
- Combined oral contraceptives: prevent LH surge → no ovulation



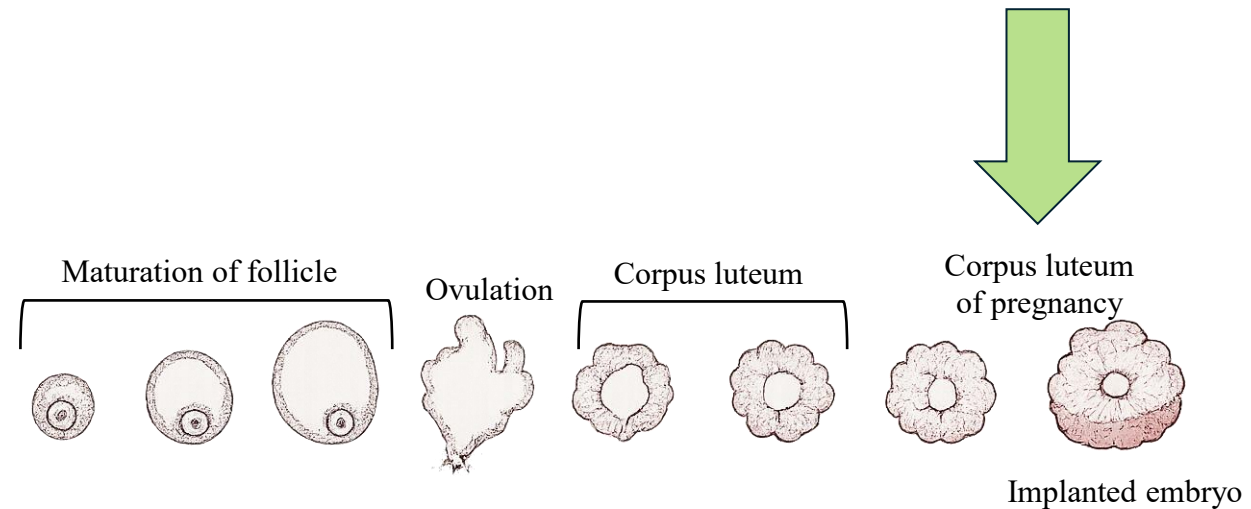
Ovarian Phase	Uterine Phase	Main Hormone
Follicular	Proliferative	Estrogen
Ovulation	—	LH surge
Luteal	Secretory	Progesterone
—	Menstrual	Progesterone withdrawal



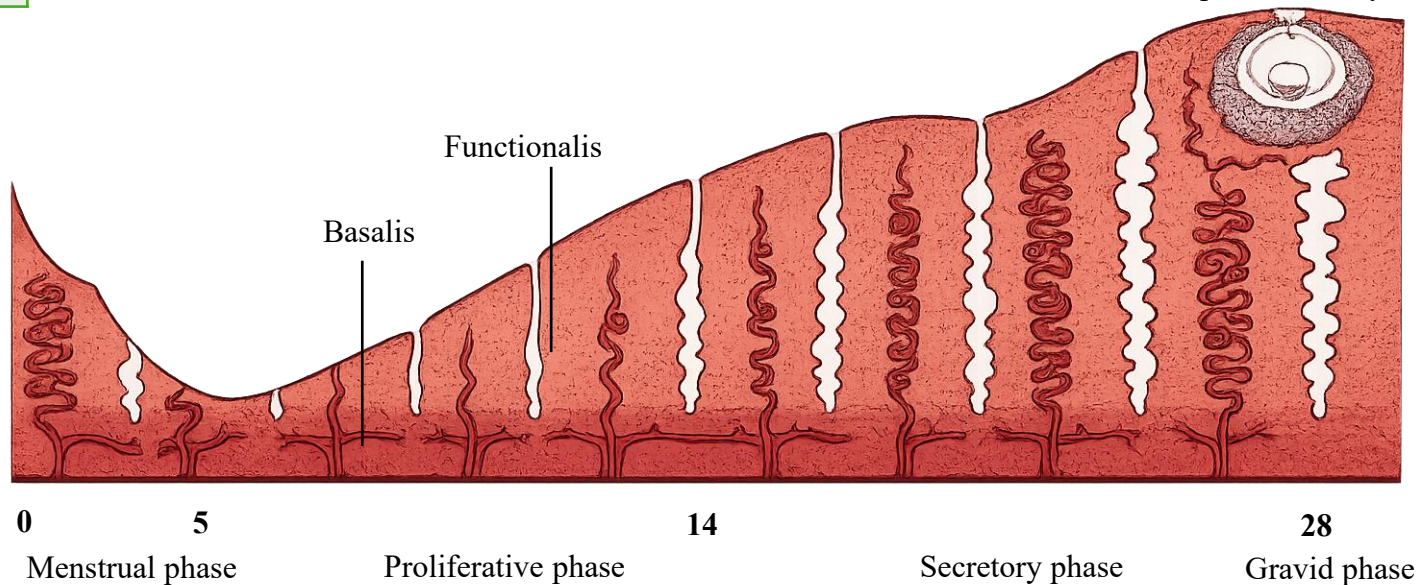
Changes in uterine mucosa (endometrium) and corresponding changes in the ovary during a regular menstrual cycle without fertilization



Ovarian Phase	Uterine Phase	Main Hormone
Follicular	Proliferative	Estrogen
Ovulation	—	LH surge
Luteal	Secretory	Progesterone
—	Menstrual	Progesterone withdrawal

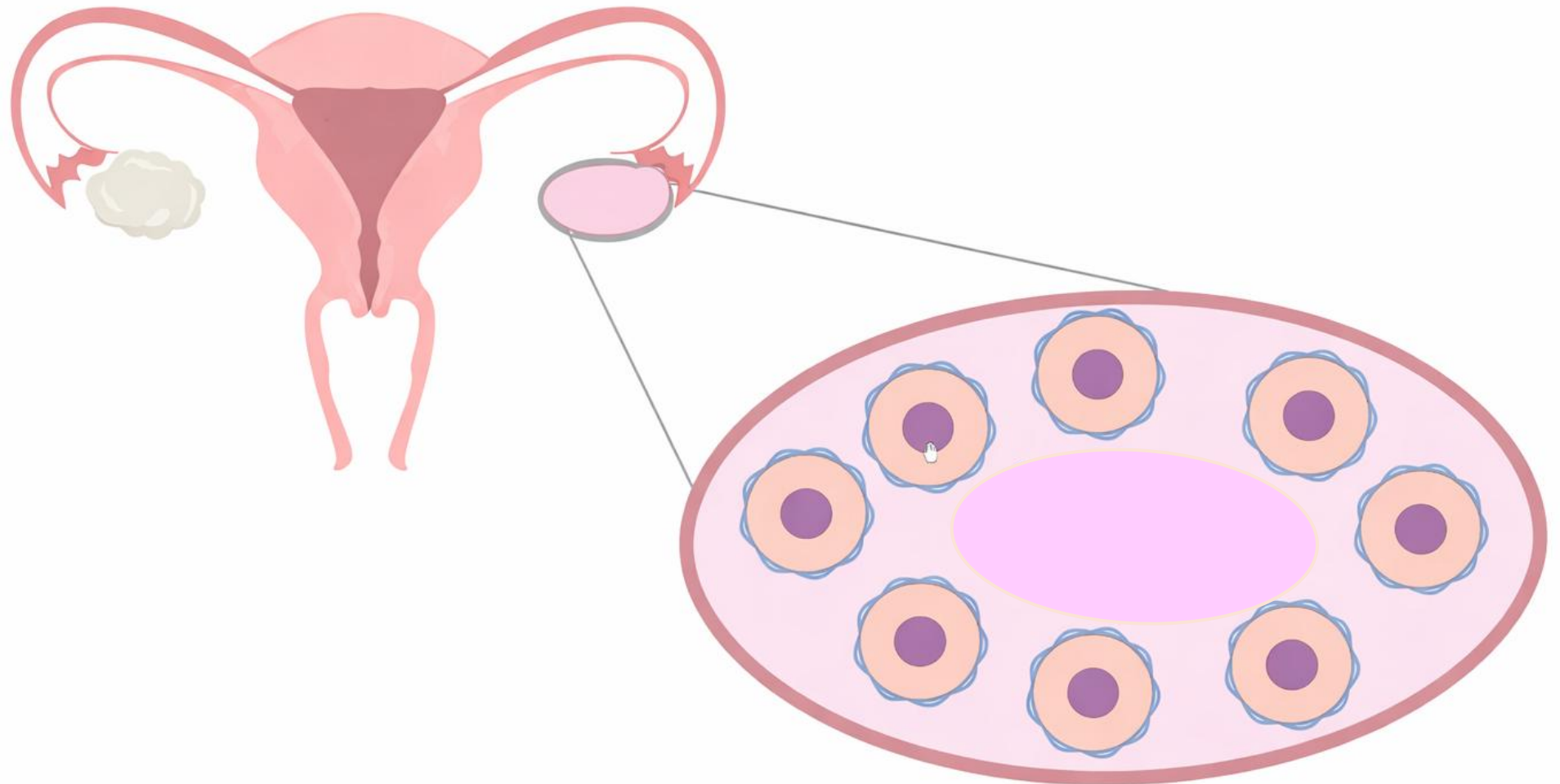


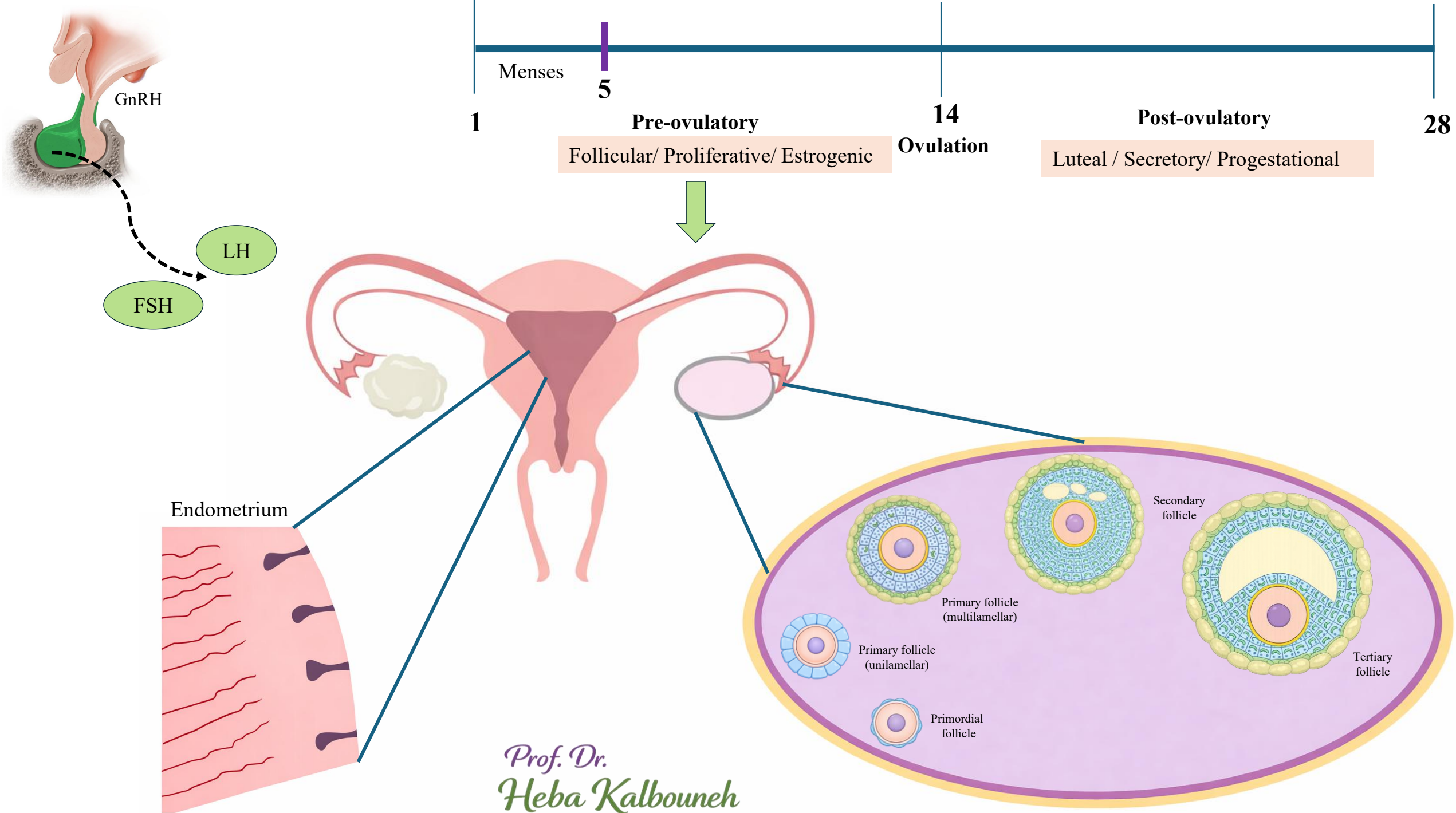
Changes in uterine mucosa (endometrium) correlated with those in the ovary. Implantation of the blastocyst has caused development of a large corpus luteum of pregnancy. Secretory activity of the endometrium increases gradually as a result of large amounts of progesterone produced by the corpus luteum of pregnancy.

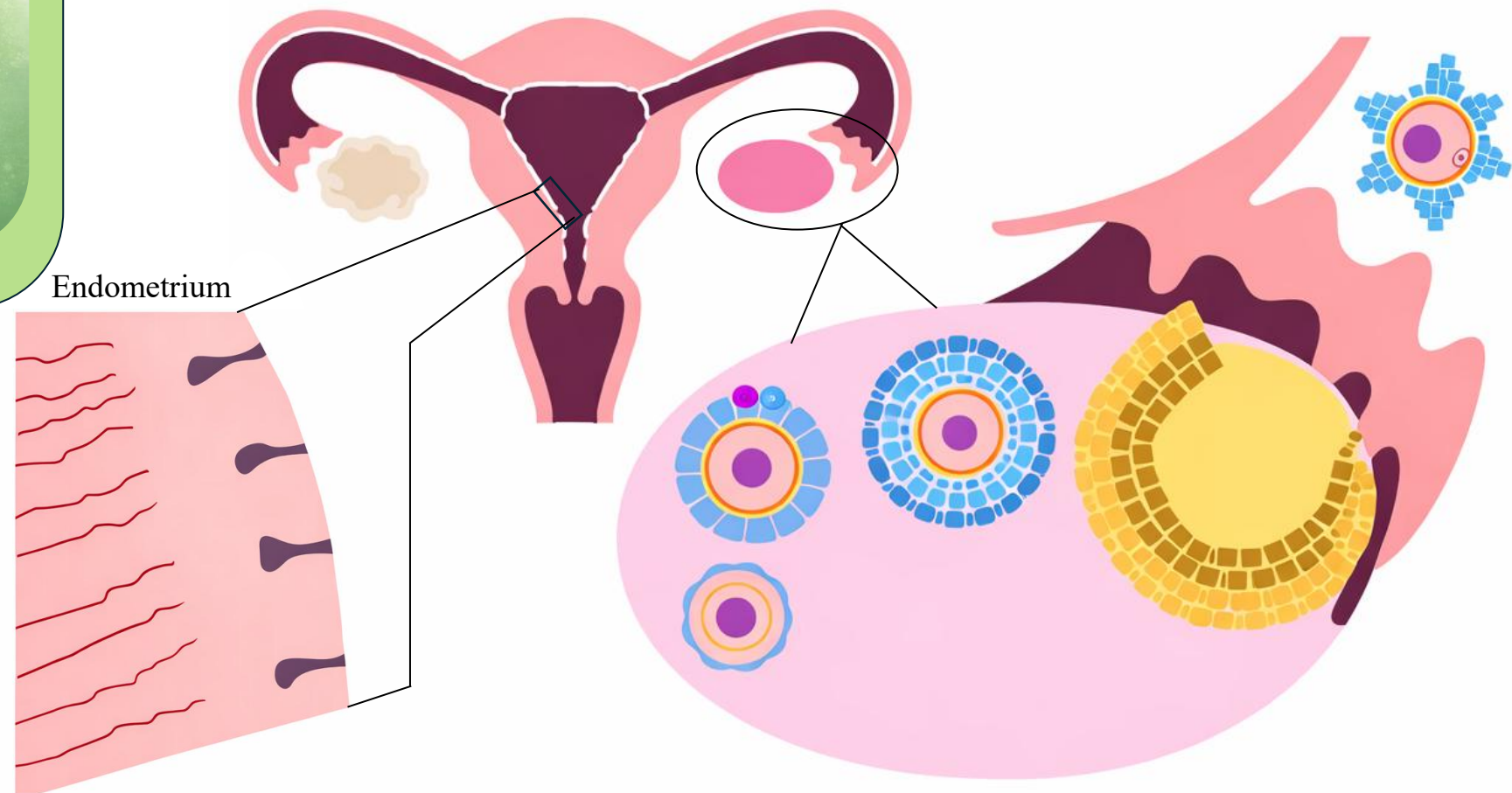
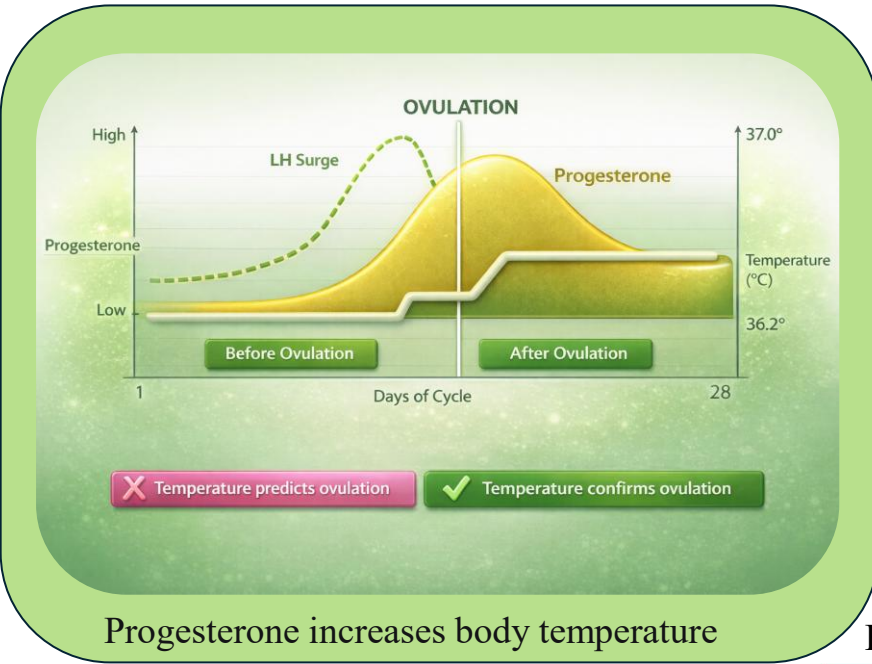
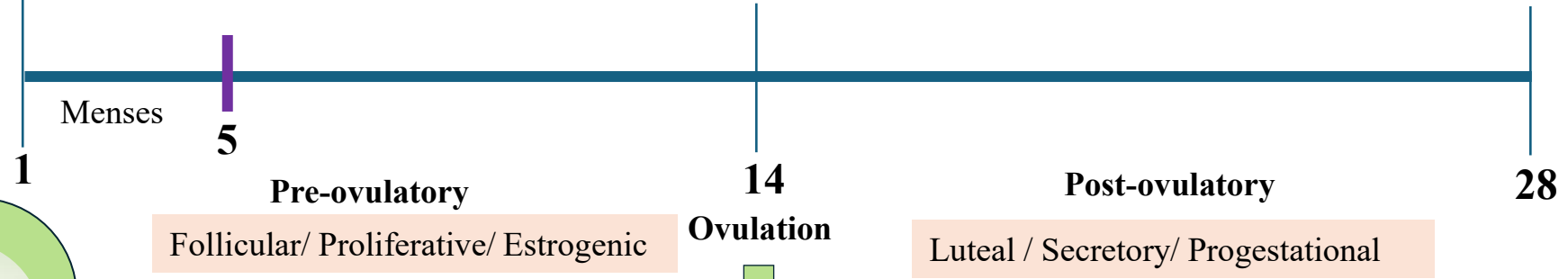


Remember:

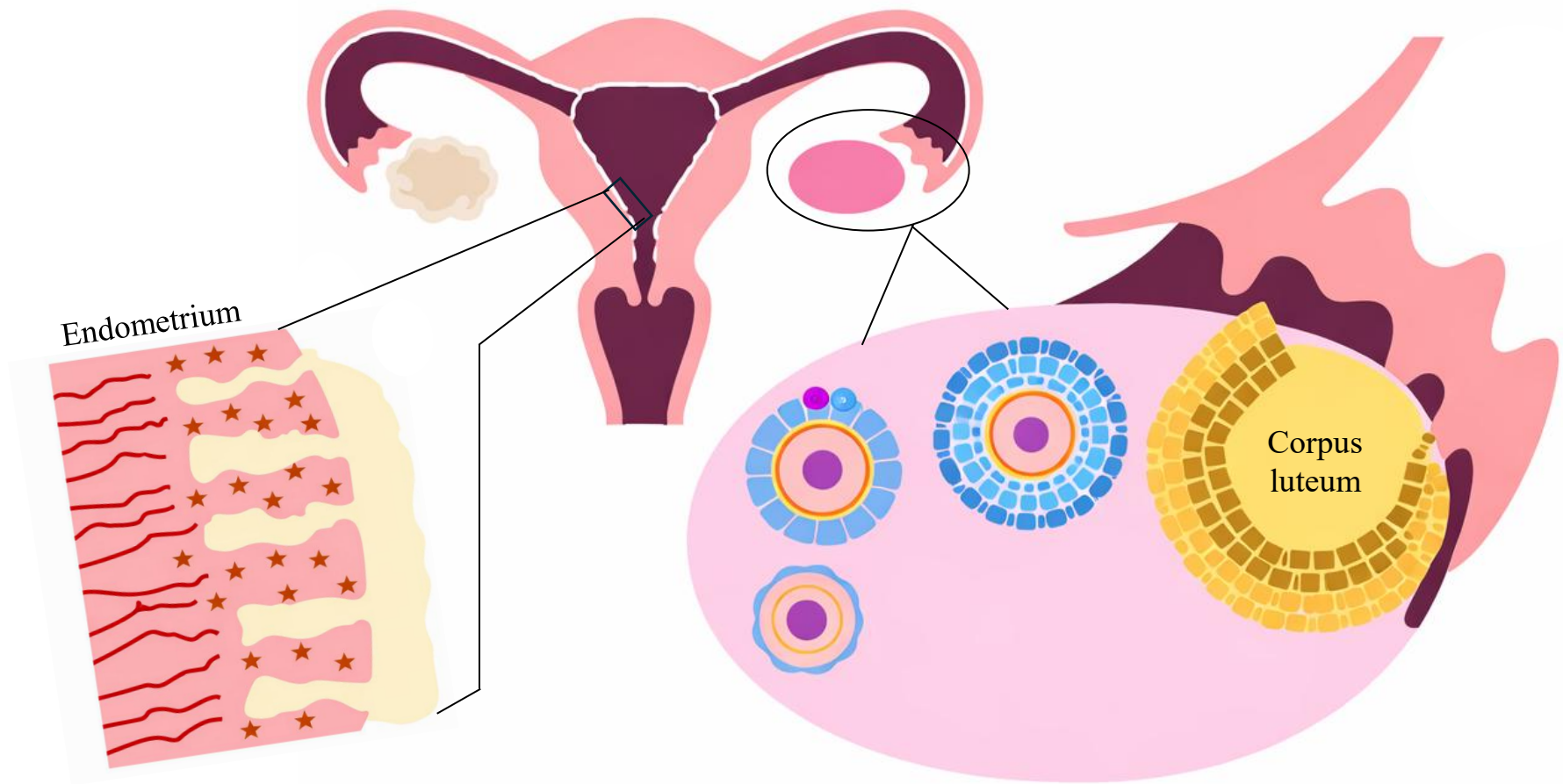
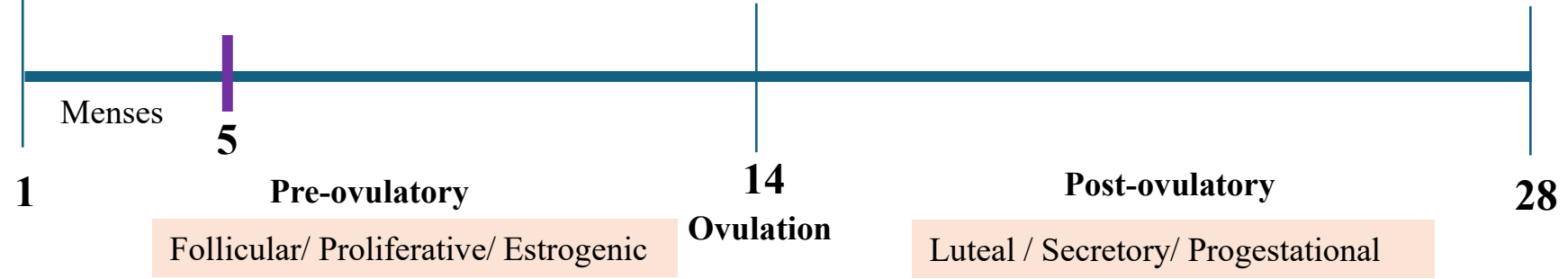
From birth until puberty, the ovary is relatively small and hormonally inactive. At birth, it contains a large number of **primordial follicles**, each composed of a primary oocyte arrested in prophase I and surrounded by a single layer of flattened follicular cells.

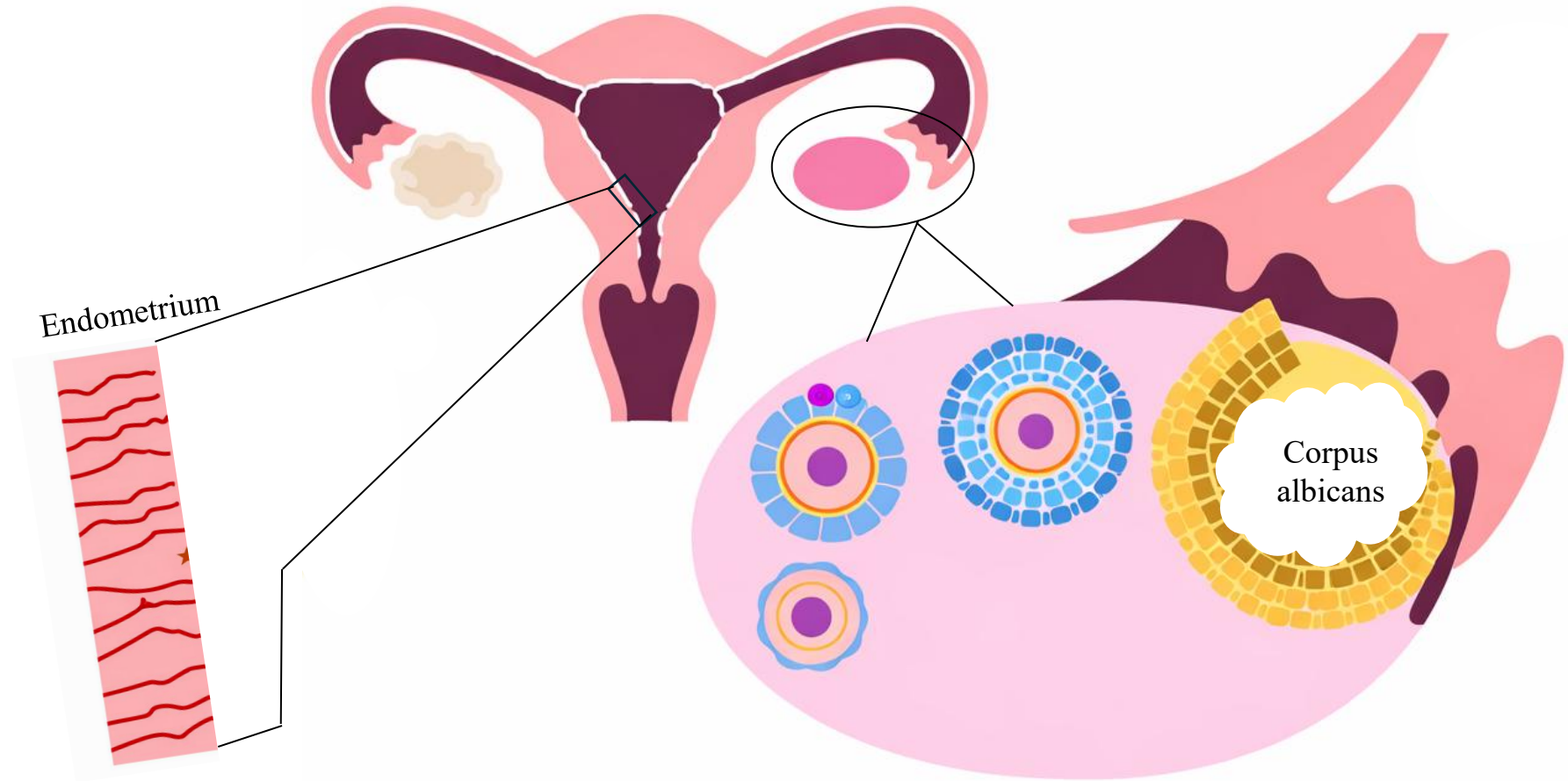
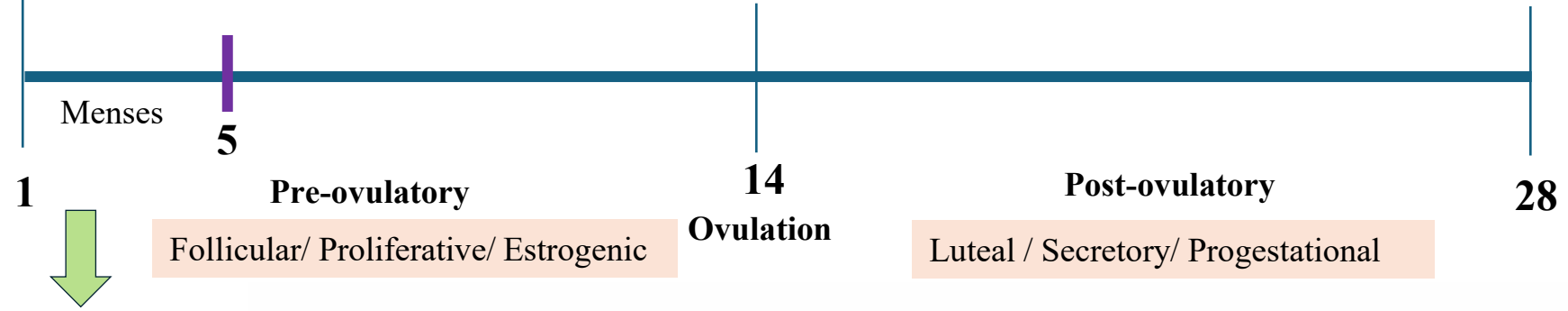
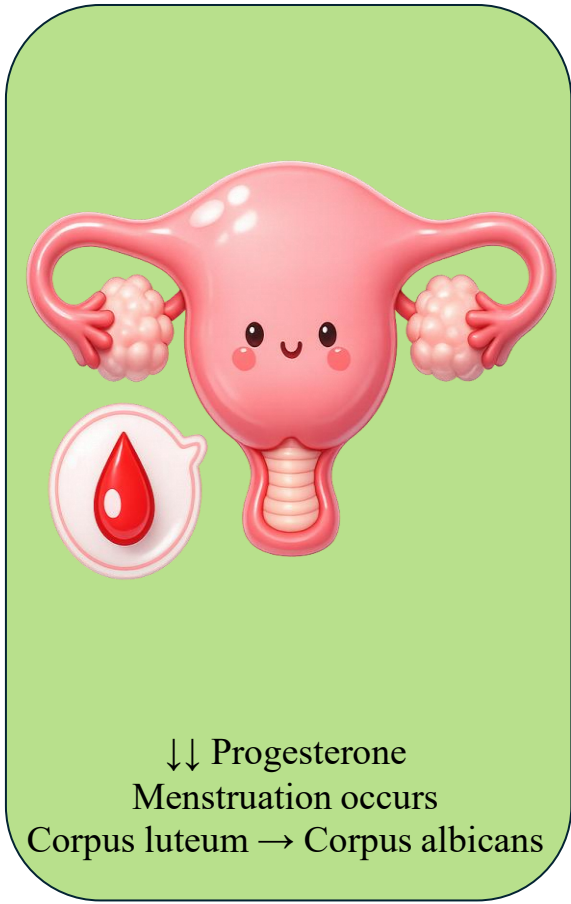


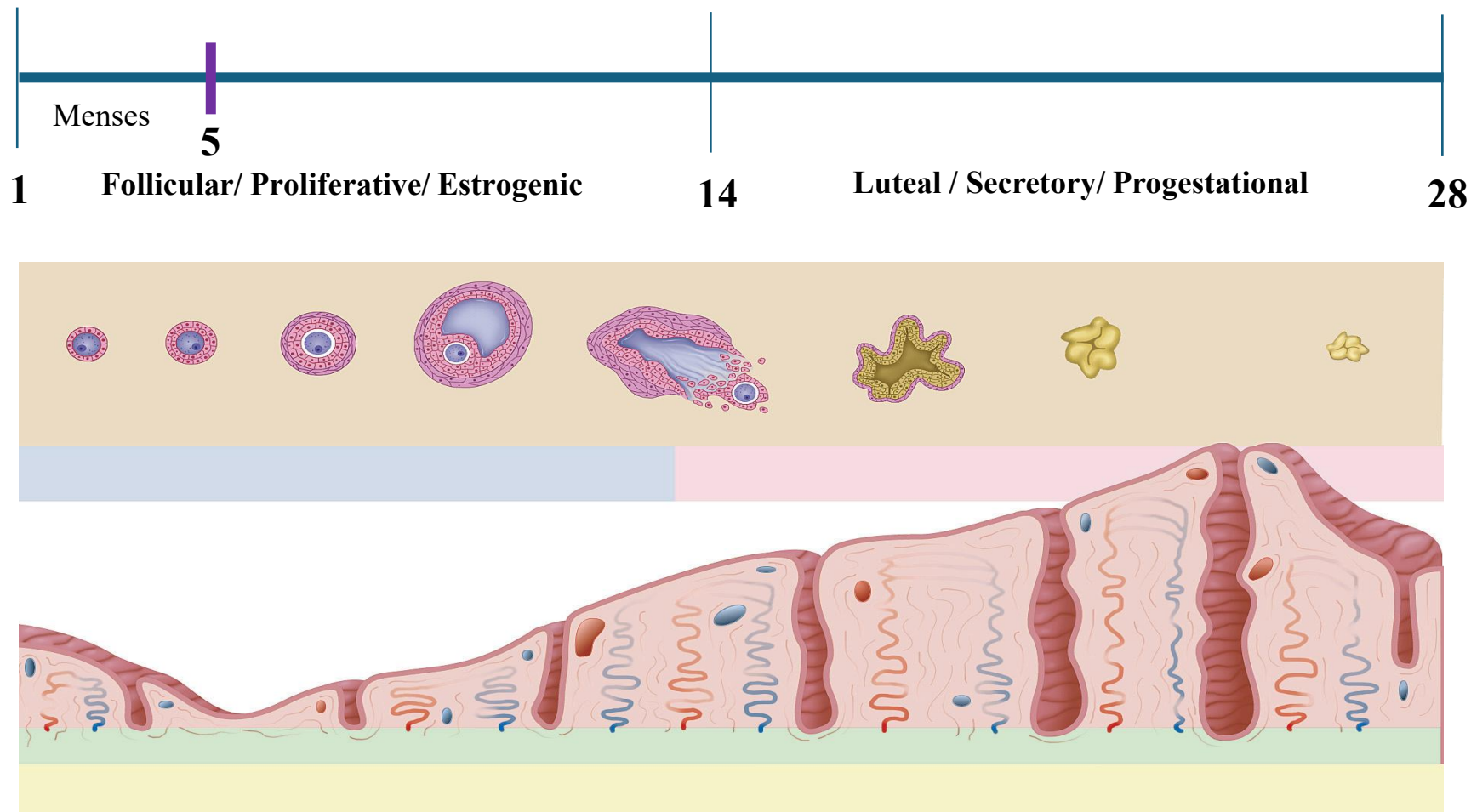




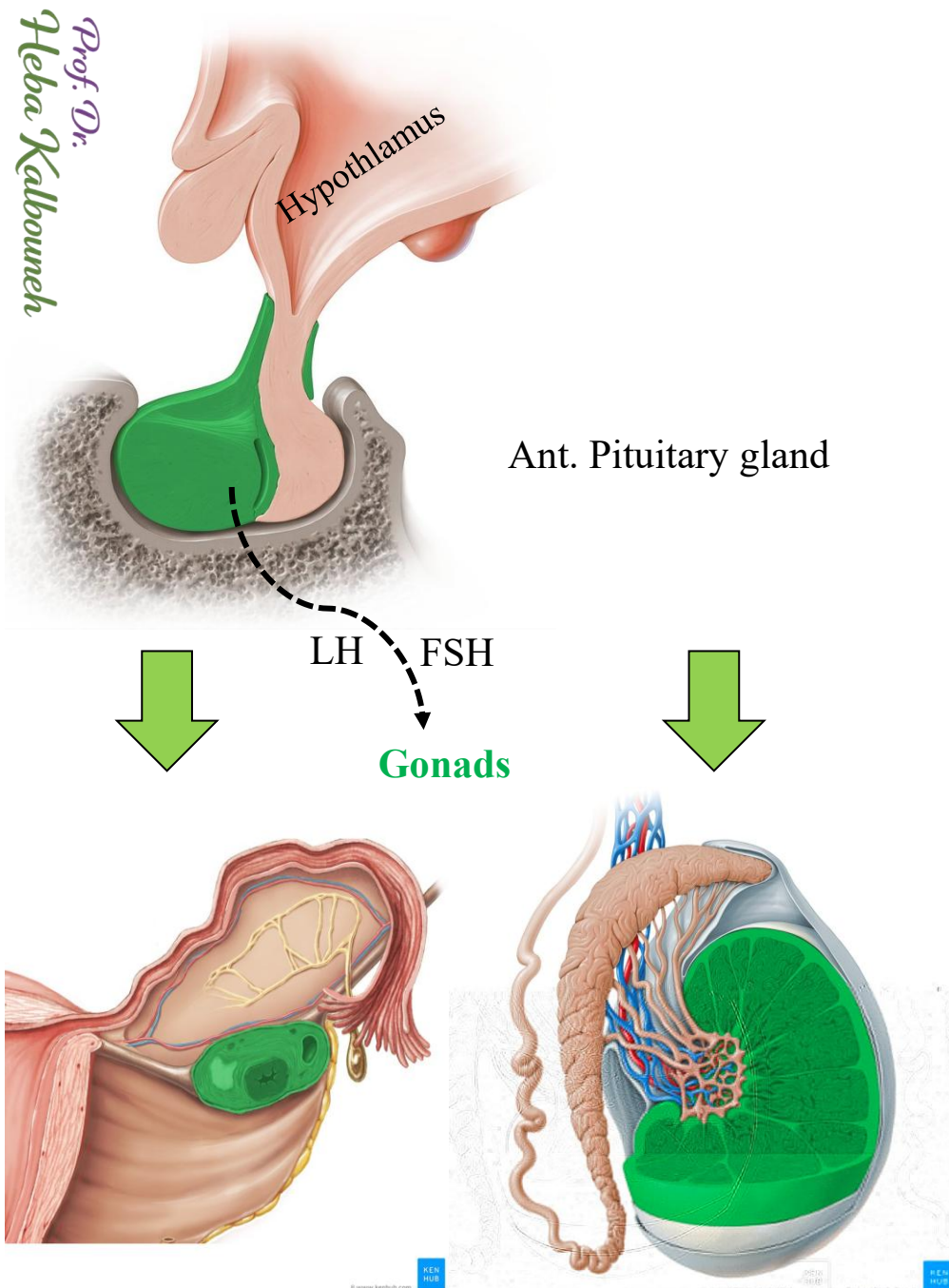
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- ✓ From puberty until menopause (~ 45-50 years), pituitary gonadotropins (FSH & LH) produce cyclic changes in ovarian hormone levels, which cause the endometrium to undergo cyclic modifications during the menstrual cycle.
- ✓ The duration of the menstrual cycle may be variable but averages 28 days. Because menstrual cycles are a consequence of ovarian follicle changes related to oocyte production, a woman is fertile only during the years when she is having menstrual cycles.
- ✓ Day 1 of the menstrual cycle is usually taken as the day when menstrual bleeding appears. The menstrual discharge consists of **degenerating endometrium mixed with blood from its ruptured microvasculature**.
- ✓ The menstrual period lasts 3-5 days on average. The next phase of the cycle, the proliferative phase, is of variable length, 8-10 days on average, and the secretory phase begins at ovulation and lasts about 14 days



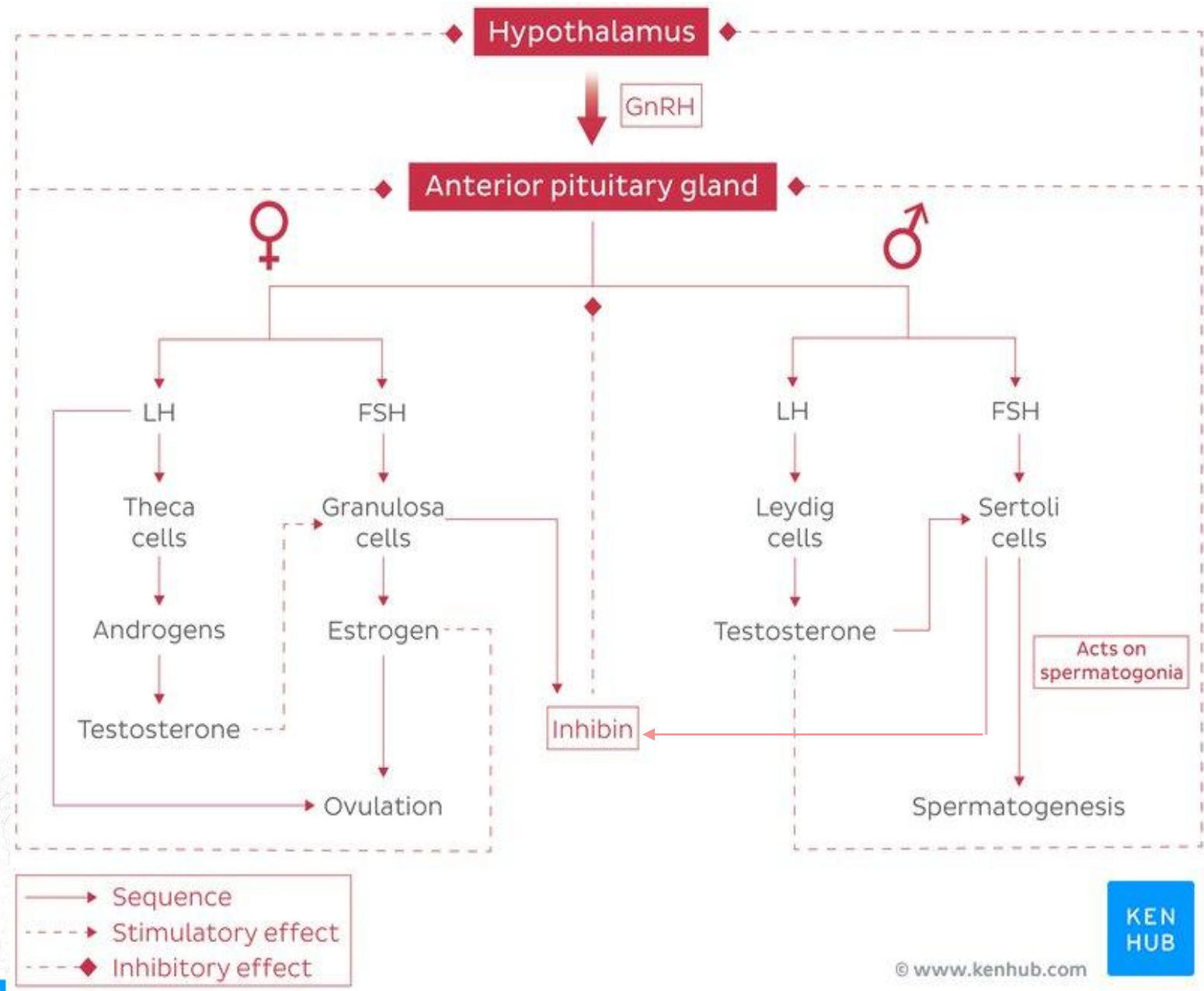
Ant. Pituitary gland

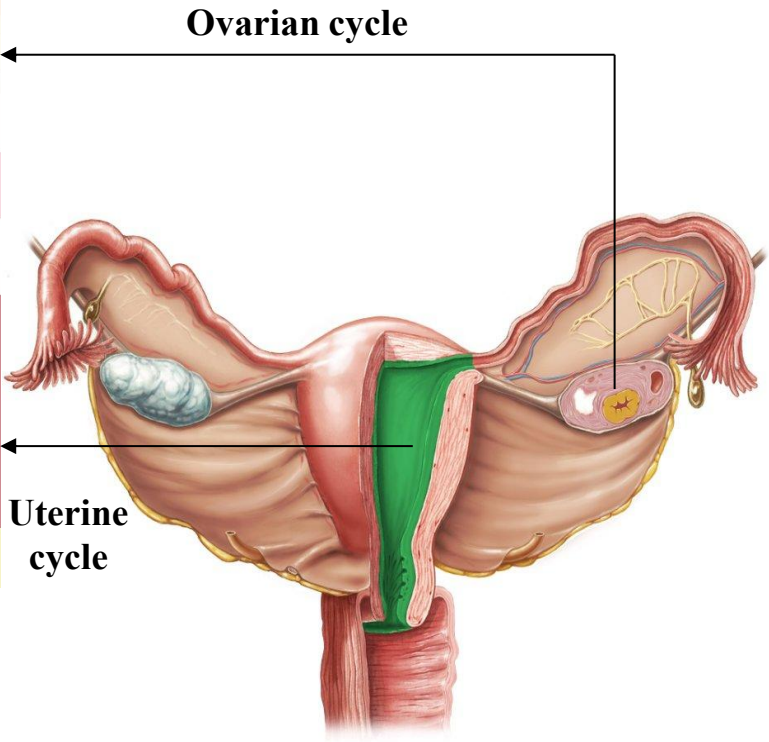
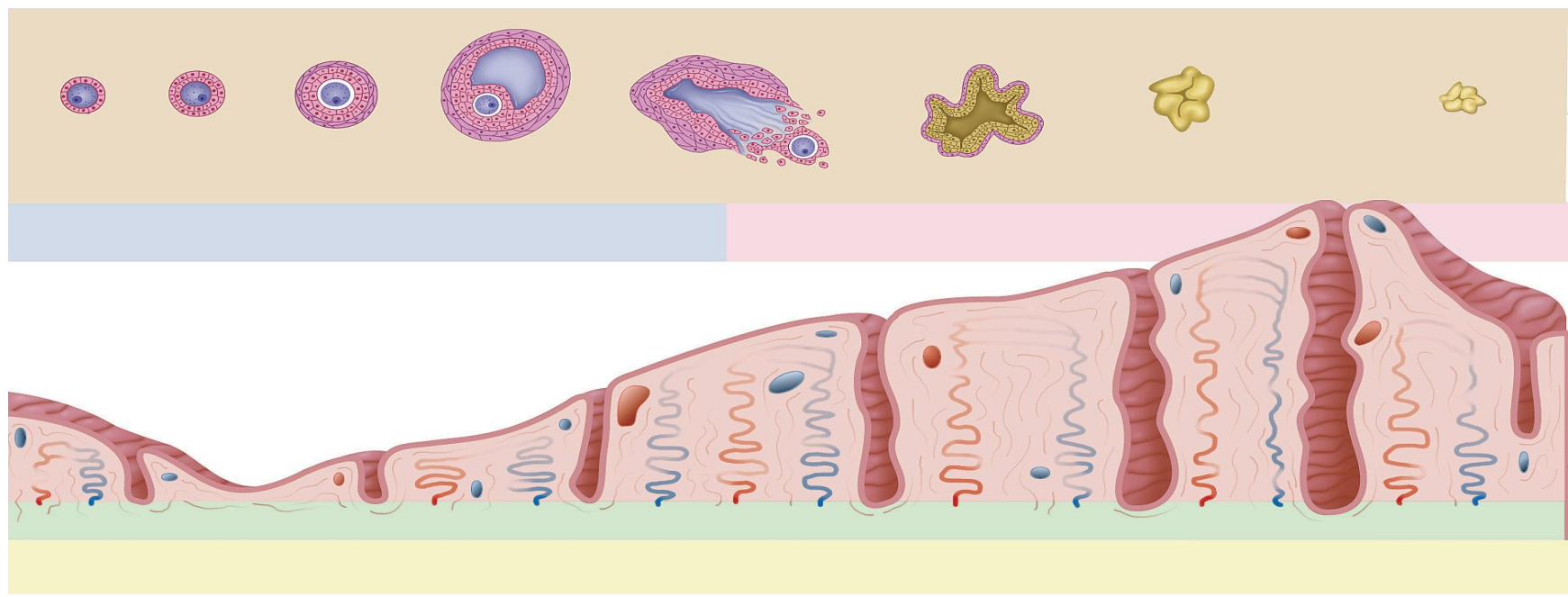
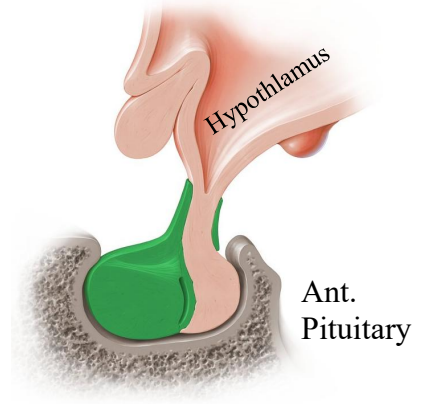
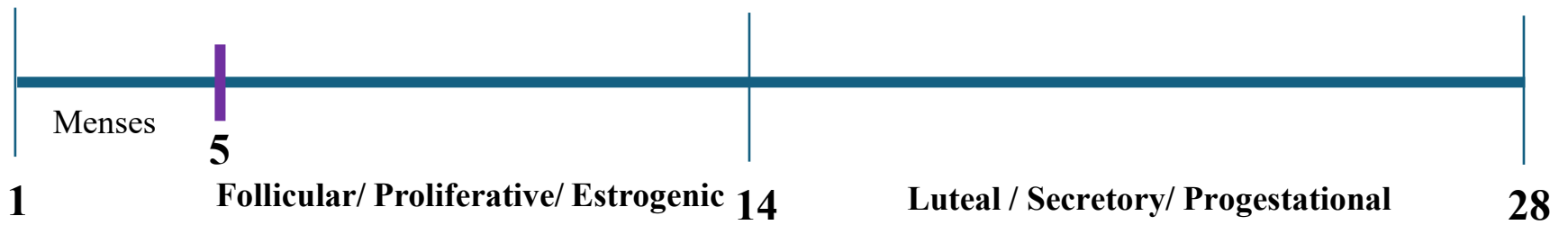
LH FSH  
Gonads



Ovary

Testis

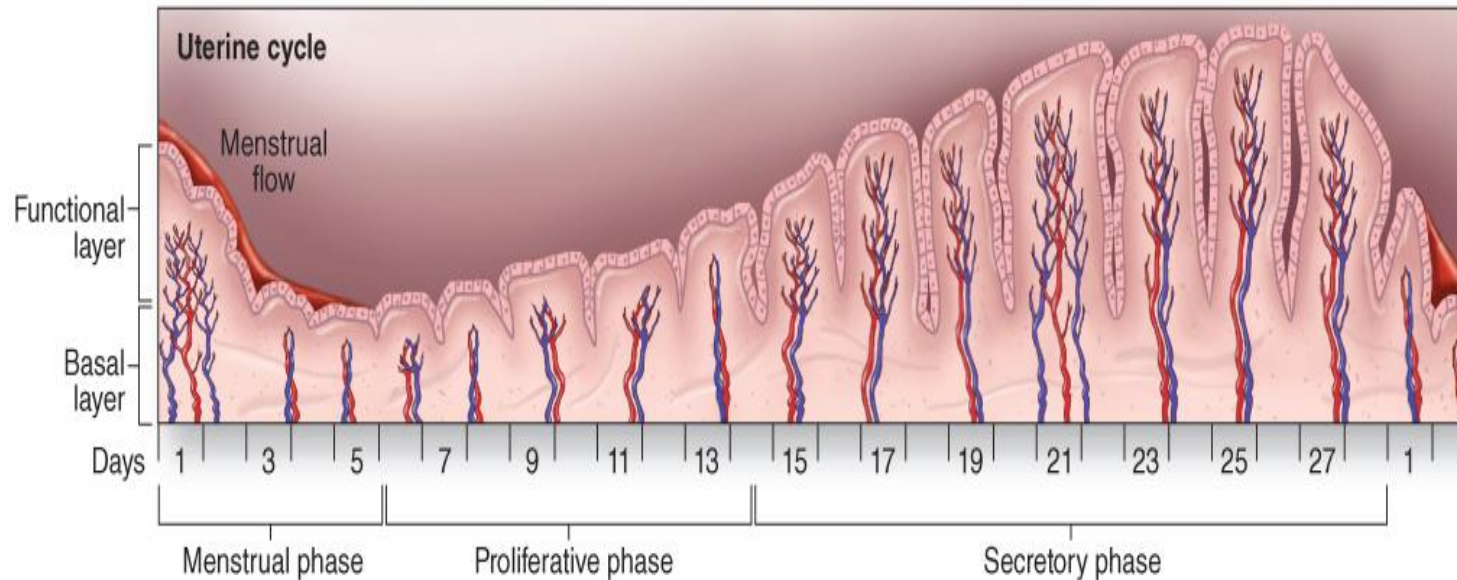
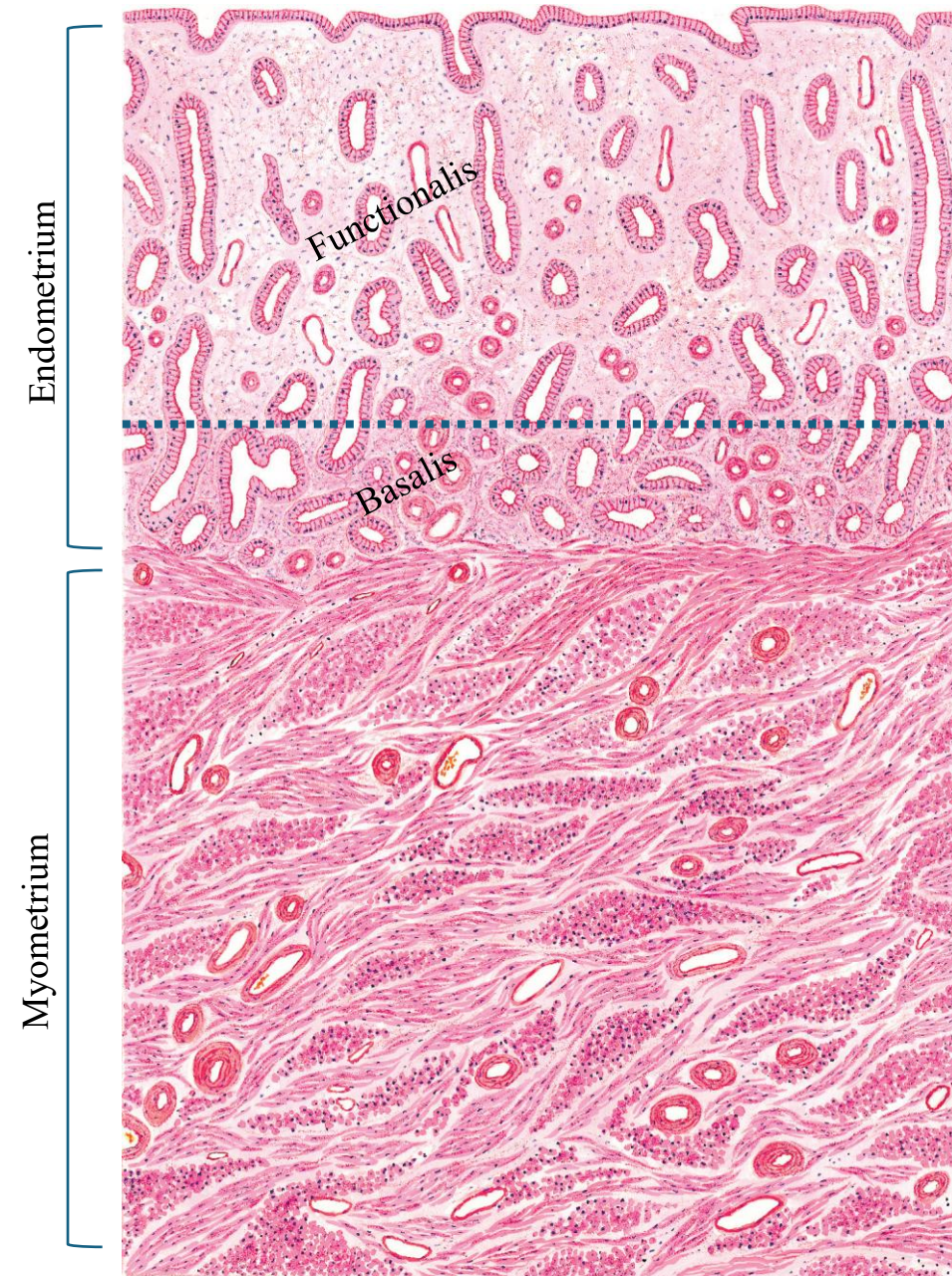




## Proliferative Phase

- ✓ After the menstrual phase, the uterine mucosa (endometrium) is relatively thin (~0.5 mm).
- ✓ Estrogens act on the endometrium, inducing regeneration of the functional layer lost during menstruation.
- ✓ Cells in the basal ends of glands proliferate, migrate, and form the new epithelial covering over the surface exposed during menstruation.
- ✓ Spiral arteries lengthen as the functional layer is reestablished and grows and extensive microvasculature forms near the surface of the functional layer.
- ✓ At the end of the proliferative phase, the endometrium is 2-3 mm thick.

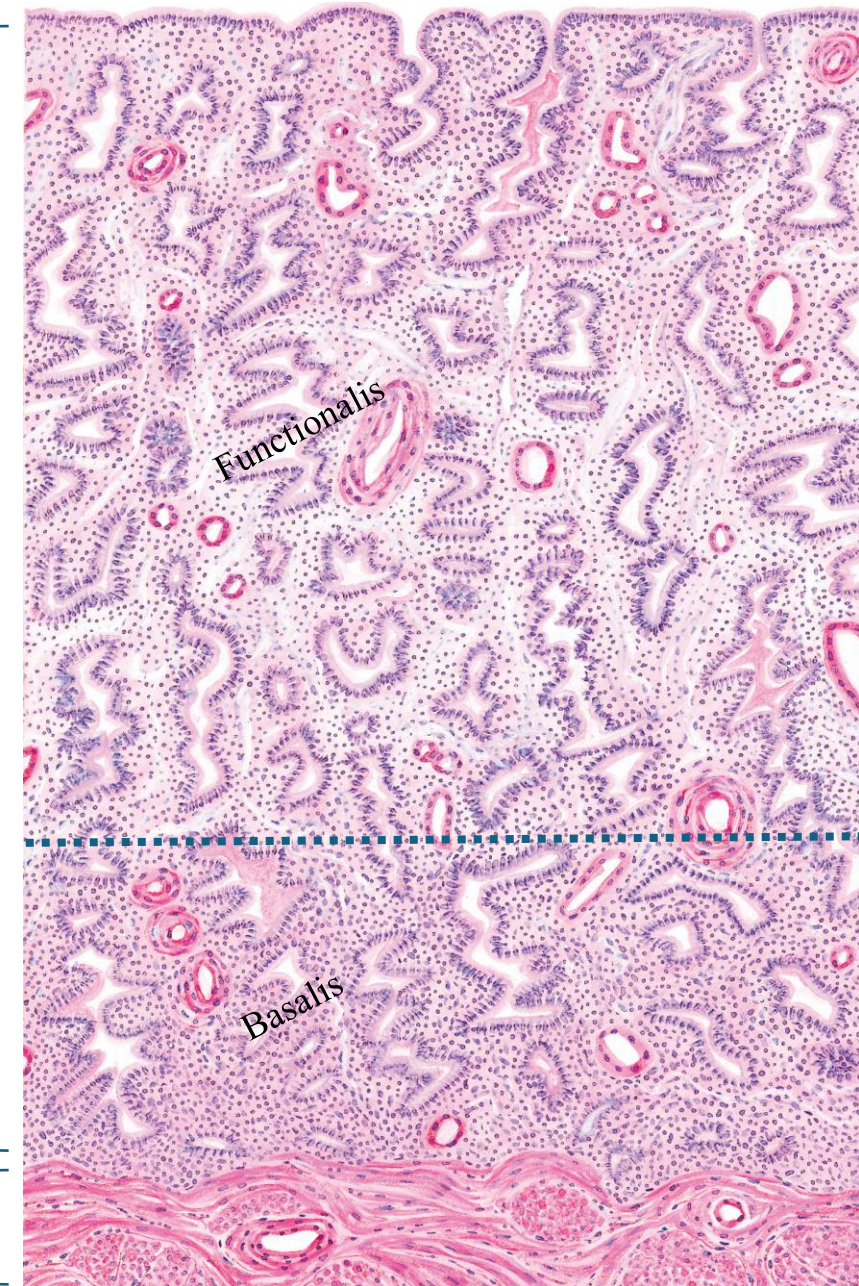
## Proliferative (follicular/ estrogenic) phase



## Secretory Phase

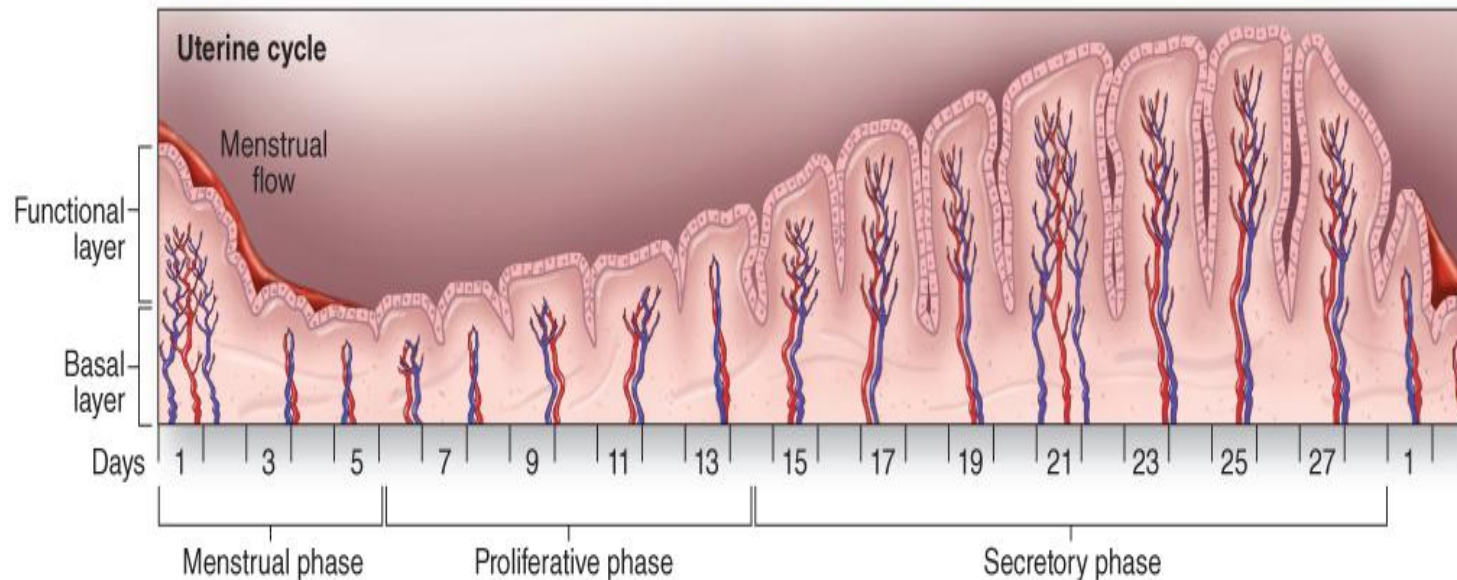
- ✓ After ovulation, the secretory phase starts as a result of the progesterone secreted by the corpus luteum.
  - ✓ Progesterone stimulates epithelial cells of the uterine glands that formed during the proliferative phase and these cells begin to secrete and accumulate glycogen, dilating the glandular lumens, and causing the glands to become coiled.
- Note: secretions rich in glycogen to support development of the embryo
- ✓ The spiral arteries become coiled.
  - ✓ The endometrium reaches its maximum thickness (5 mm) during the secretory phase as a result of the accumulation of secretions and edema in the stroma.

## Secretory (luteal/ Progestational) phase



Endometrium

Myometrium



## Proliferative (follicular) phase

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## Secretory (luteal) phase



During the proliferative phase, the uterine glands are relatively straight tubules with narrow, nearly empty lumens

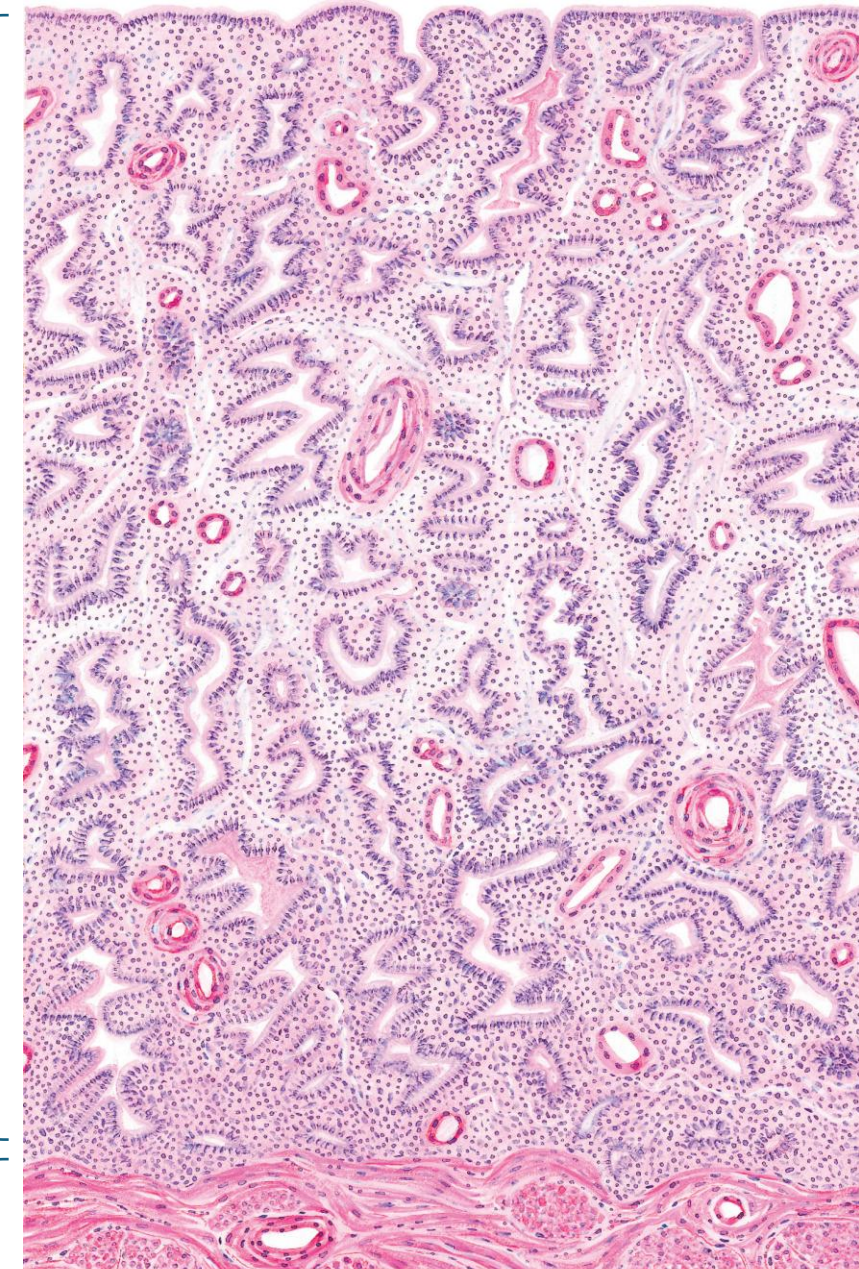
Endometrium

In the secretory phase, the functional layer is four times thicker than the basal layer. The tubular glands have wider lumens containing secretory product and coiled giving a zigzag or folded appearance histologically

Note:

During pregnancy, the glands and blood vessels in the endometrium further increase in size and number.

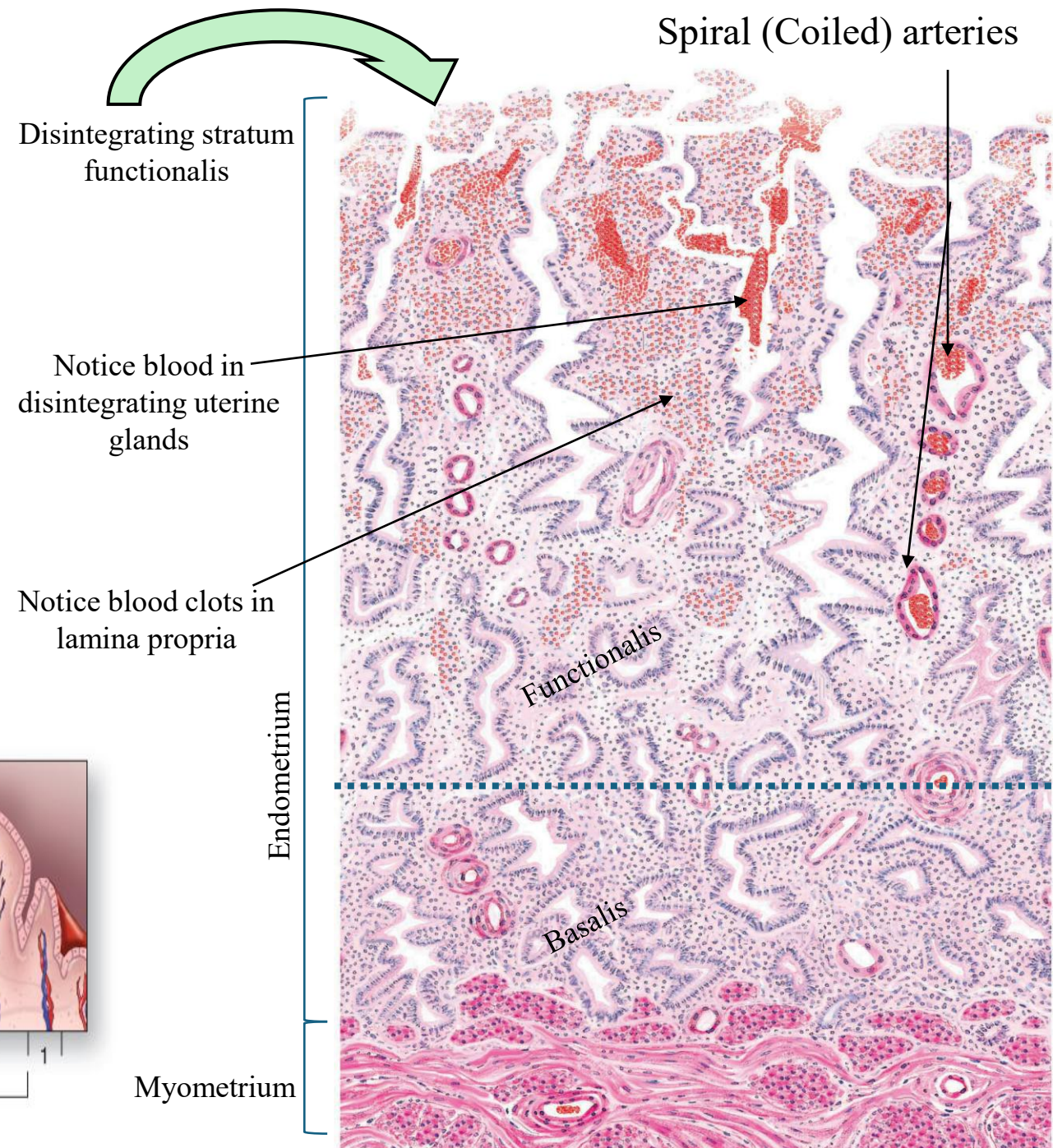
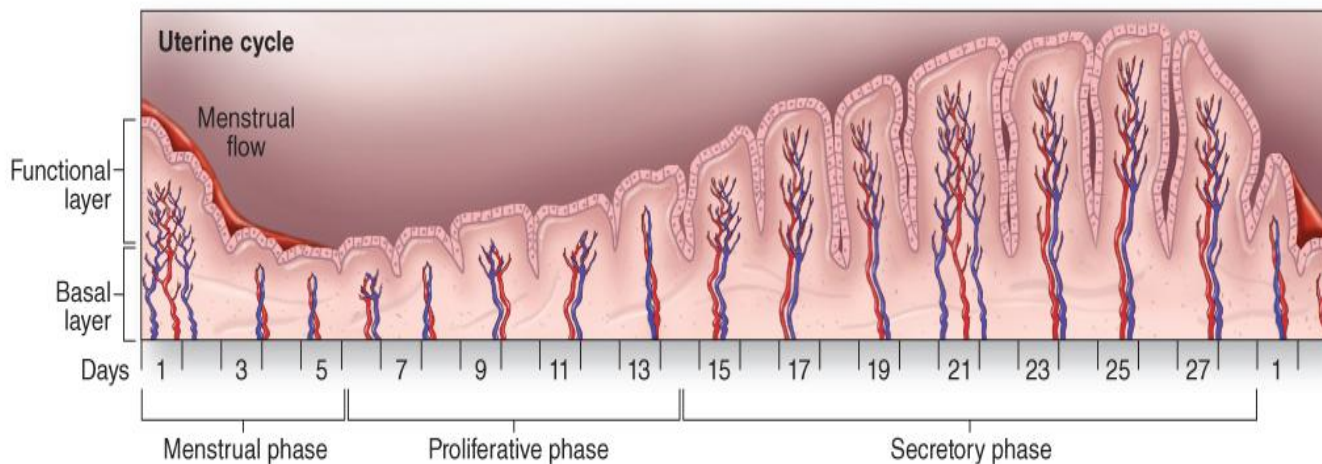
Myometrium



## Menstrual phase

- ✓ Menstruation is initiated each month by falling levels of progesterone (and estrogen) and the release of prostaglandins, which constrict the spiral arteries.
- ⇒ *This causes them to spasm, contract and break up.*
- ✓ The blood supply to the endometrium is cut off and the cells of the stratum functionalis become deprived of oxygen and die.
- ✓ Later the whole layer is lost and passed out as menstrual bleeding, and only the stratum basalis is left in place

Menopause is a variably timed period during which the cyclic changes become irregular and eventually disappear. In the postmenopausal period the reproductive organs slowly involute.



## Correlation of ovarian and uterine cycles with levels of their controlling hormones.

The cyclic development of ovarian follicles and the corpus luteum, controlled by FSH and LH, lead to cyclic shifts in the levels of the major ovarian hormones: estrogen and progesterone.

Estrogen stimulates the proliferative phase of the uterine cycle and its level peaks near the day of ovulation, which marks the midpoint of the ovarian cycle. After ovulation the corpus luteum forms and produces both progesterone and estrogen, which together promote growth and development of the endometrial **functional layer**. Unless fertilization and implantation of an embryo occur, regression of the corpus luteum leads to declining levels of the steroid hormones and failure of the new endometrial tissue to be maintained. This tissue sloughs off as the menstrual flow, the first day of which is taken to mark day 1 of both the ovarian cycle and the uterine cycle. The basal layer of endometrium is not sensitive to the loss of progesterone and is retained during menstruation, serving to regenerate the functional layer during the ensuing proliferative phase.

