
بسم الله الرحمن الرحيم

Female Monthly Sexual Cycle

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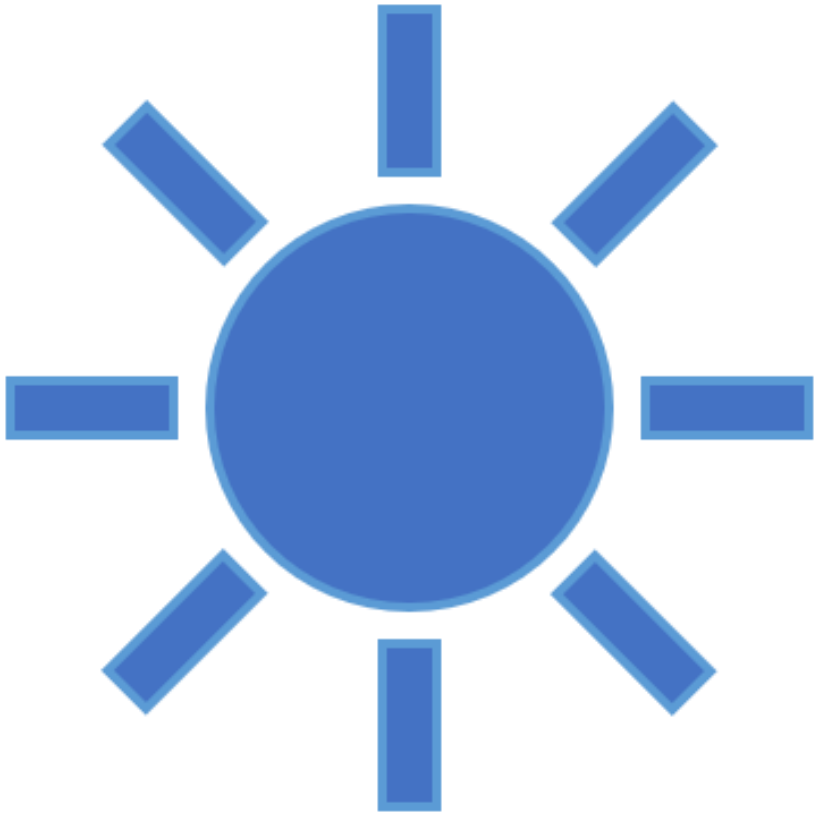
Learning Objectives

By the end of the lecture a second year MBBS student should be able to

- Describe the monthly ovarian cycle.
- Describe the effects of gonadotropic hormones on the ovaries.
- Describe the monthly Endometrial Cycle and Menstruation.
- Explain the regulation of female monthly Rhythm by hormonal interplay.

The Monthly Sexual Cycle



FSH and LH are secreted by anterior Pituitary at 9-12 years of age

Puberty and Menarche

Average menstrual cycle is 28 days

20 to 45 days in some women

Abnormal length is associated with decreased fertility

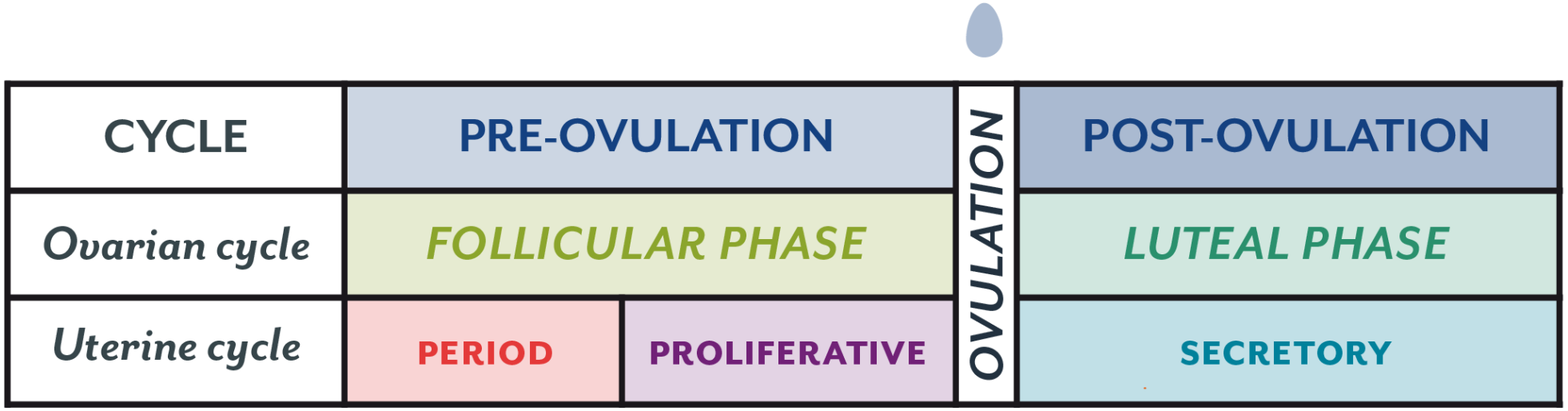
The Female Monthly Sexual Cycle

Starts at Puberty and Ends at Menopause

Each cycle - the female reproductive tract is prepared for fertilization and implantation of an ovum from the ovary at ovulation

If fertilization does not occur, the cycle repeats

If fertilization occur → Pregnancy the cycles are interrupted


CYCLE
PRE-OVULATION
OVULATION
POST-OVULATION
Ovarian cycle
FOLLICULAR PHASE
LUTEAL PHASE
Uterine cycle
PERIOD
PROLIFERATIVE
SECRETORY

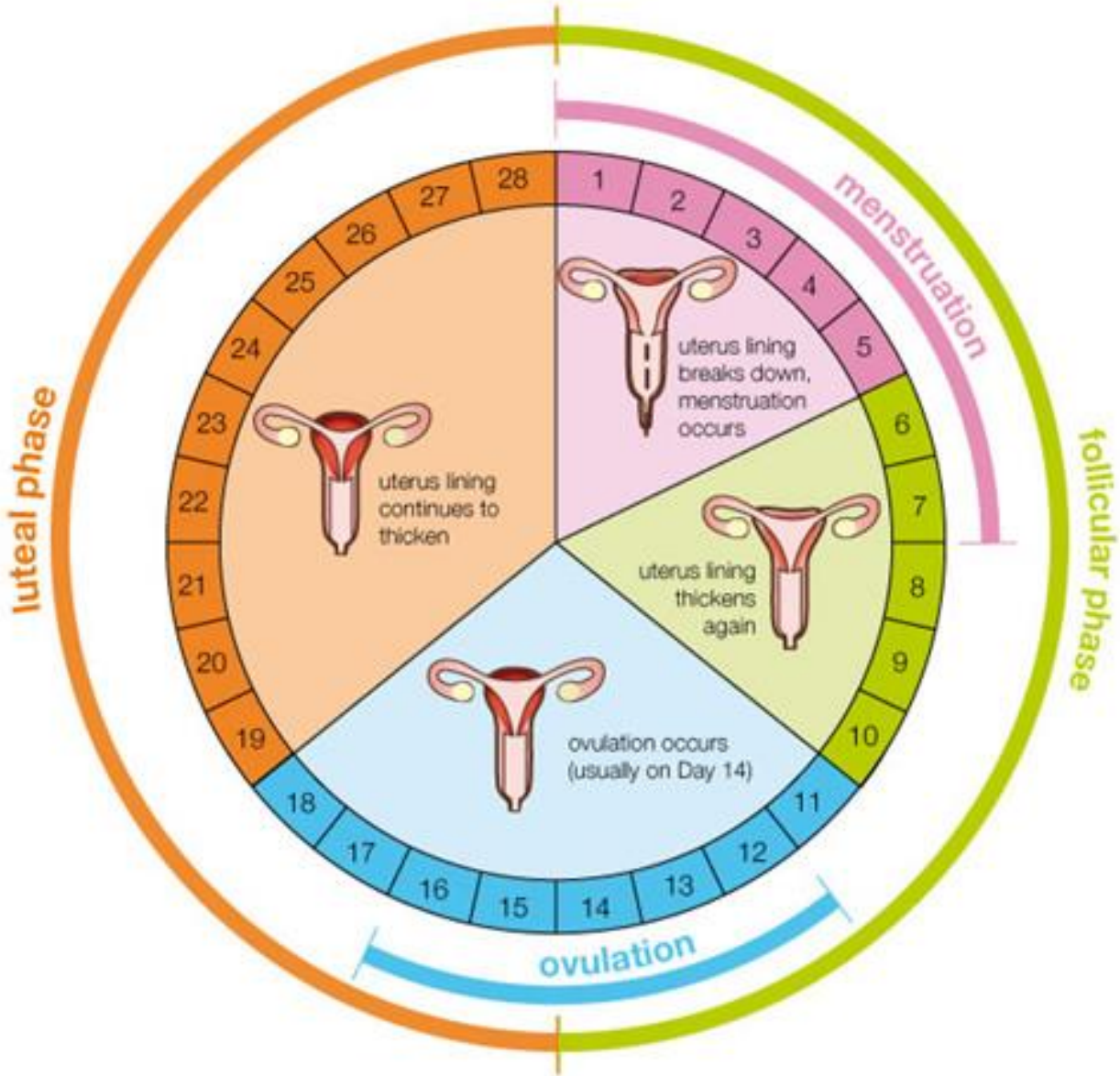
Cycle

THE OVARIAN CYCLE

FOLLICULAR (preovulatory) PHASE			LUTEAL (postovulatory) PHASE		
Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Primordial Follicle to Primary Follicle	*Primary Follicle to Secondary Follicle*	*Secondary Follicle to Tertiary Follicle*	*Tertiary follicle to Ovulation*	*Ovulation to Corpus Luteum*	*Corpus Luteum to Corpus Albicans*
[FSH & ESTROGENS]			[LH & PROGESTRONE]		

THE UTERINE CYCLE

MENSTURAL (menses) 1-5	PROLIFERATIVE 6-14	SECRETORY 15-26	PREMENSTURAL 27-28


luteal phase
follicular phase
menstruation
ovulation
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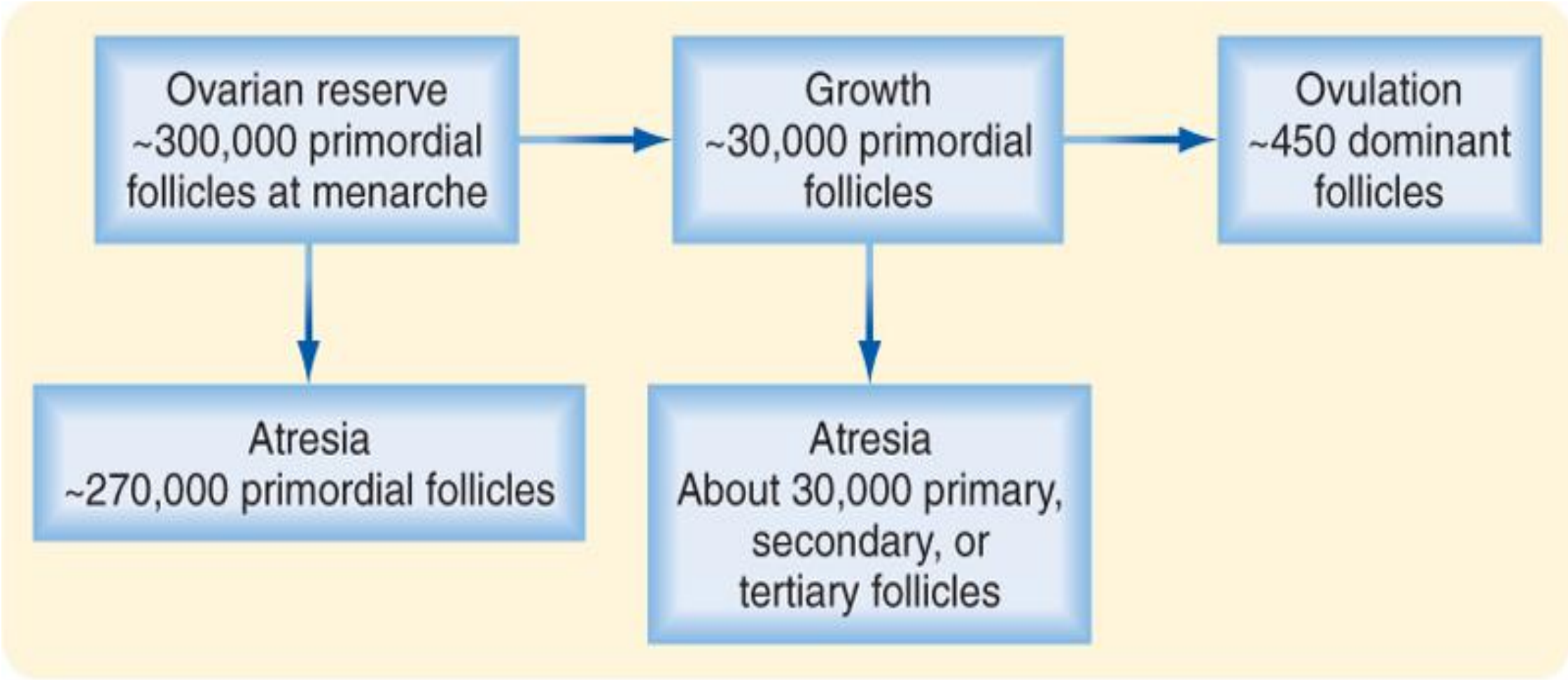
28
uterus lining breaks down, menstruation occurs
uterus lining thickens again
ovulation occurs (usually on Day 14)
uterus lining continues to thicken

The Follicular Phase

Ovarian Follicles



Accelerated Follicular Growth

Estrogen causes granulosa cells to form more FSH receptors

Pituitary FSH & estrogens promote LH receptors on granulosa cells → LH & FSH Stimulation and rapid ↑ in follicular Secretion

Estrogen from follicles and increasing LH from Pituitary cause ↑ follicular proliferation and secretion

Fate of Follicles

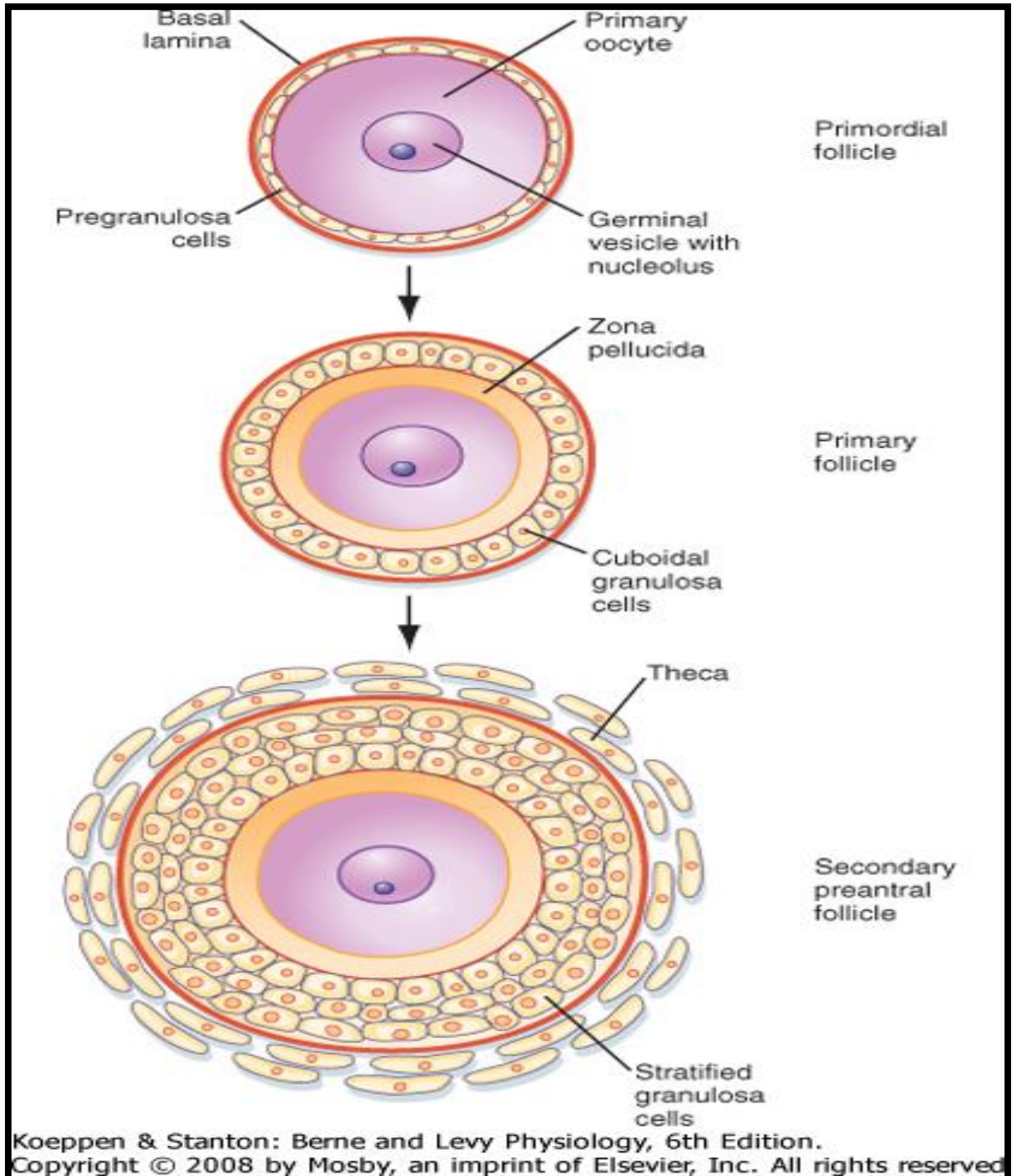
One follicle Fully matures Each Month

Remaining 5-11 developing follicles involute → Atresia

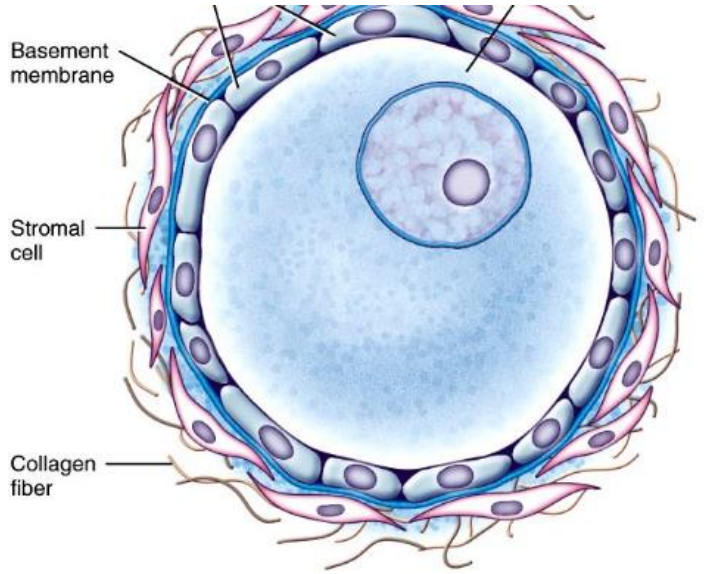
Large amount of Estrogen act on hypothalamus to ↓ FSH

One follicle reaches a diameter of 1-1.5cm → Mature Follicle

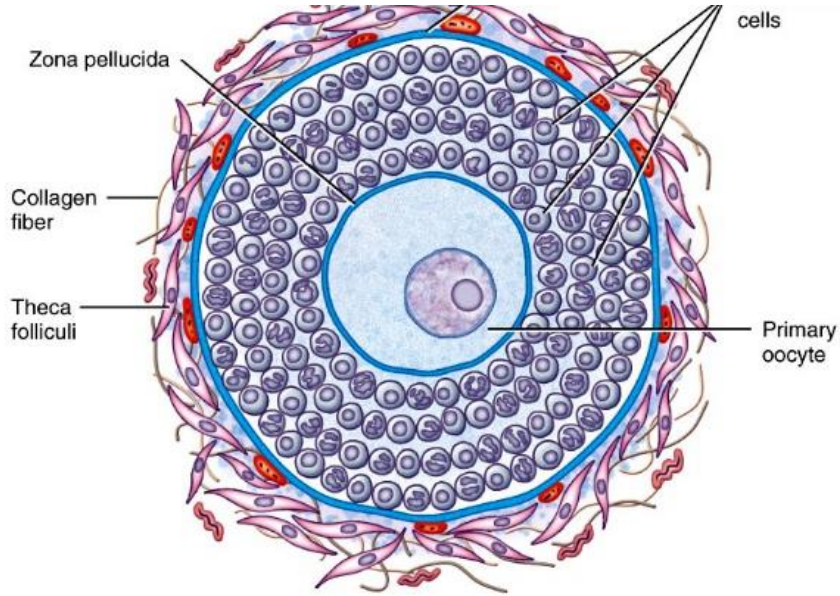
Follicular Development



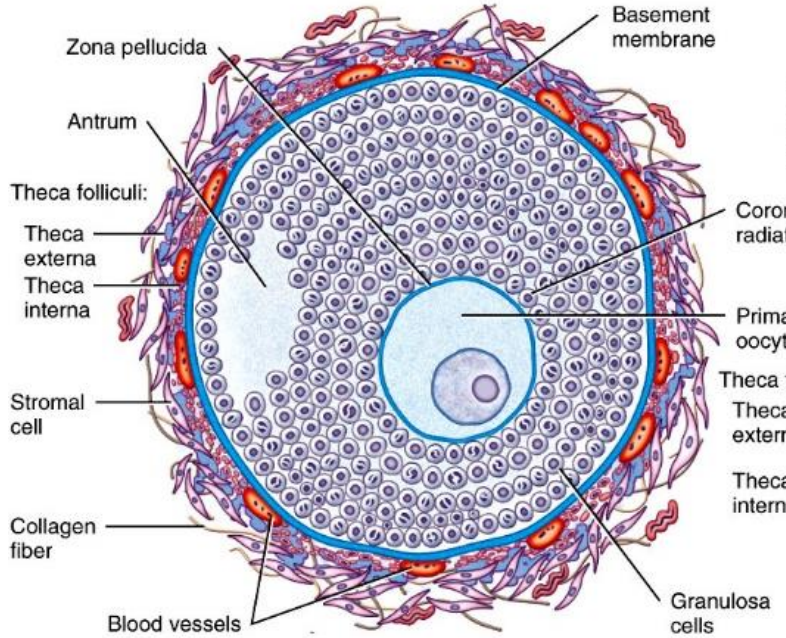
Follicular Development



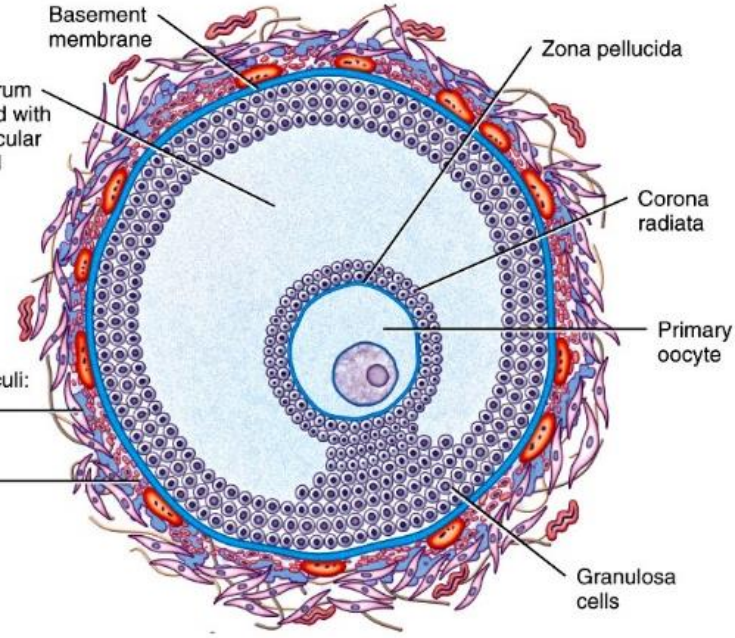
(a) Primordial follicle



(b) Late primary follicle

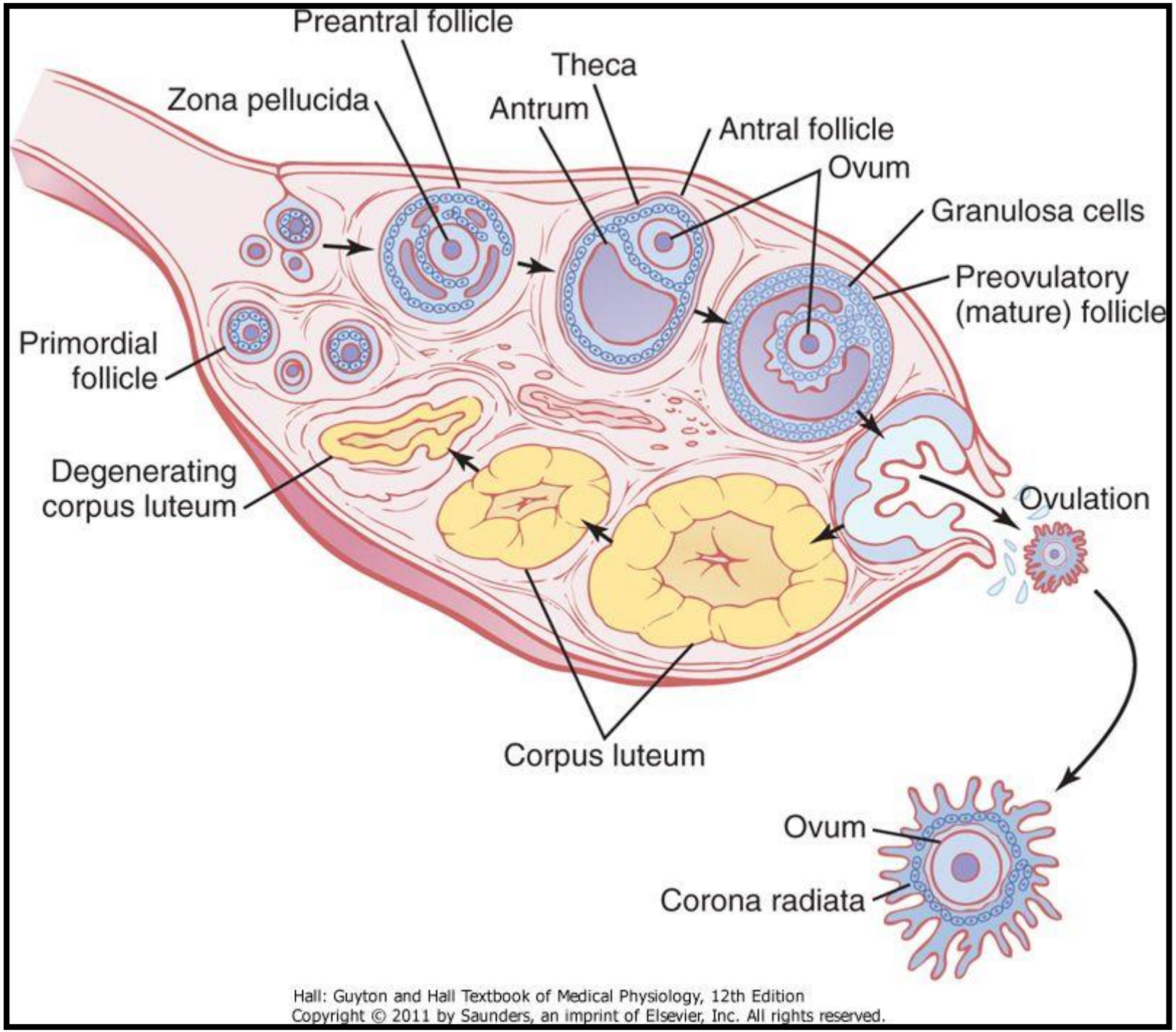


(d) Secondary follicle



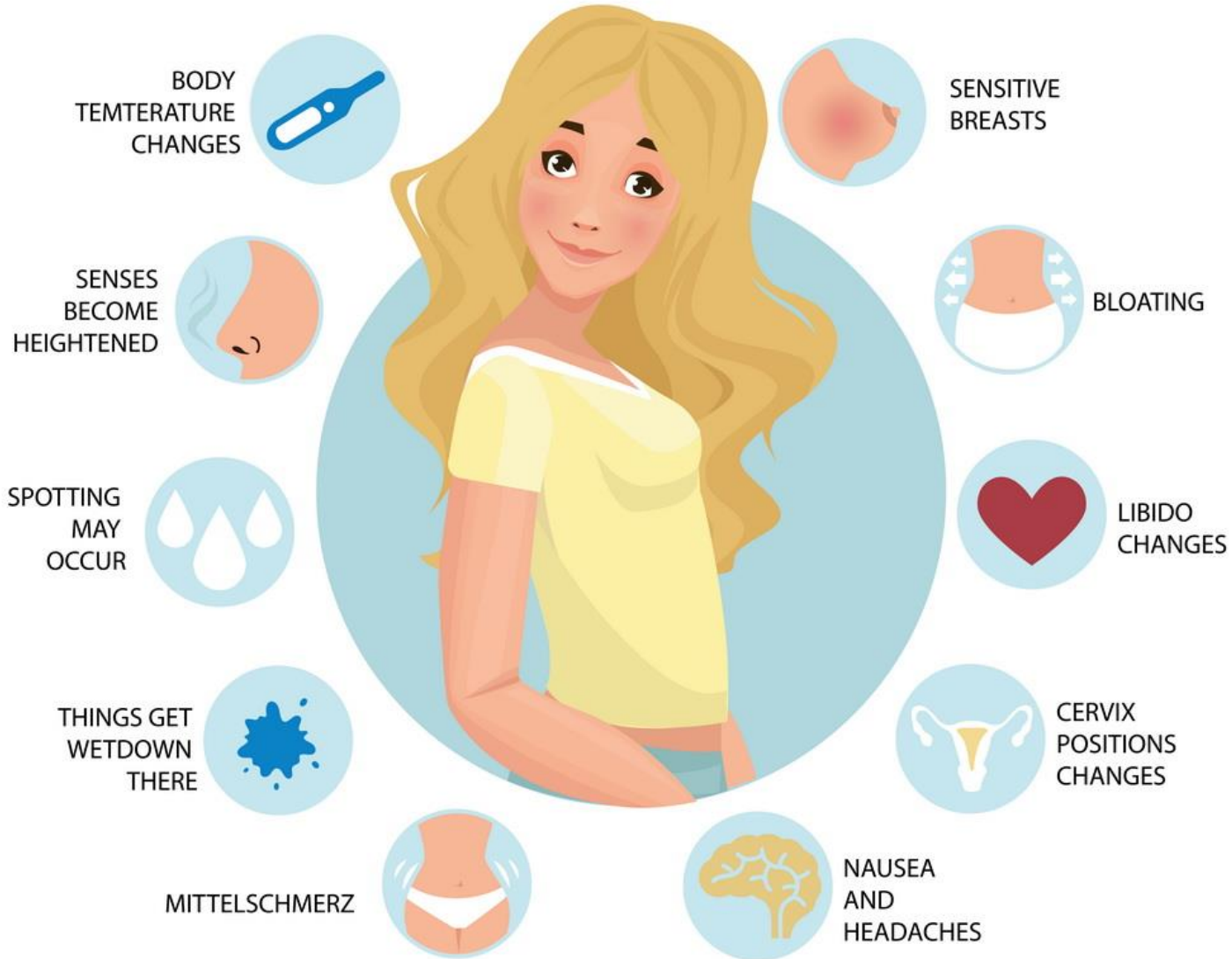
(d) Mature (graafian) follicle

Stages of Follicular Development

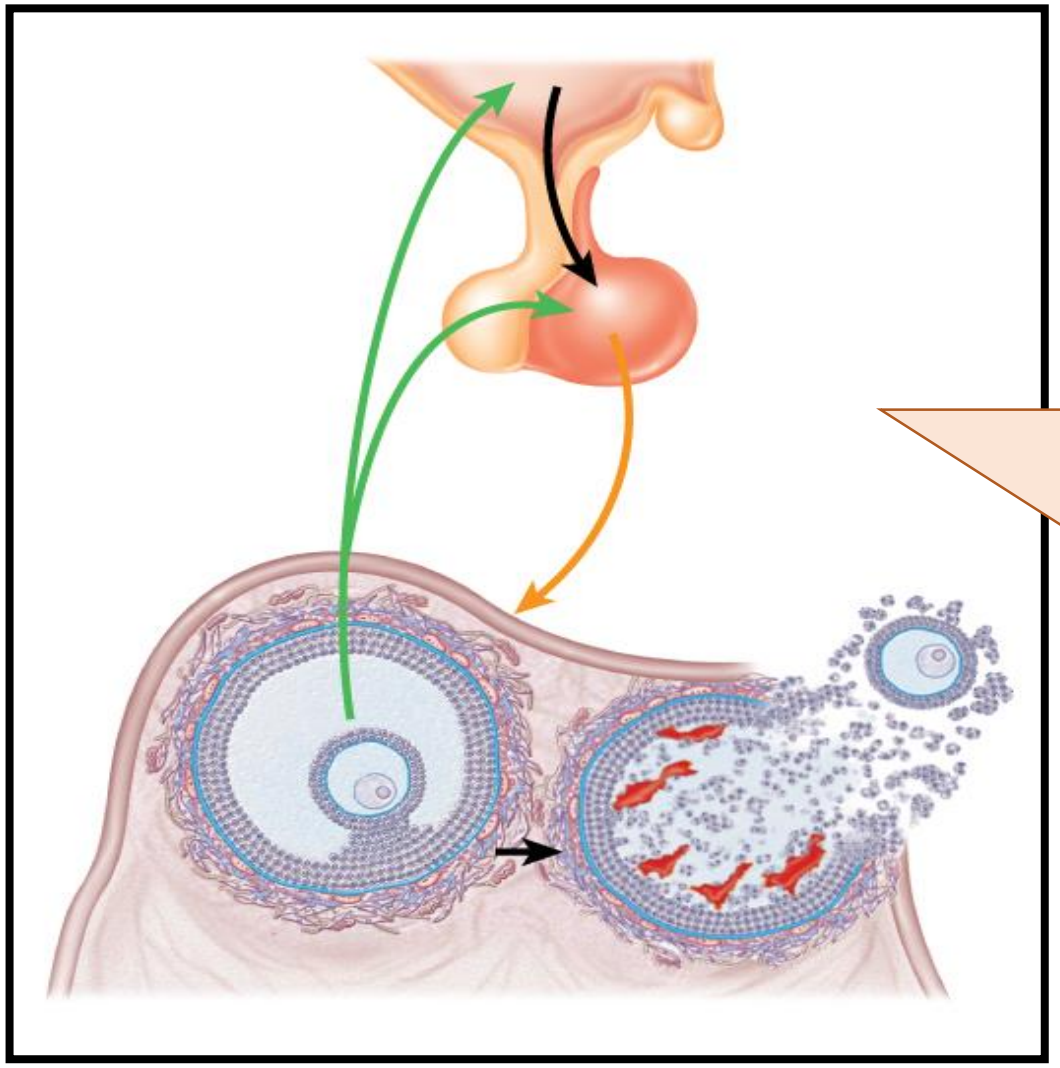


Ovulation

SYMPTOMS OF OVULATION

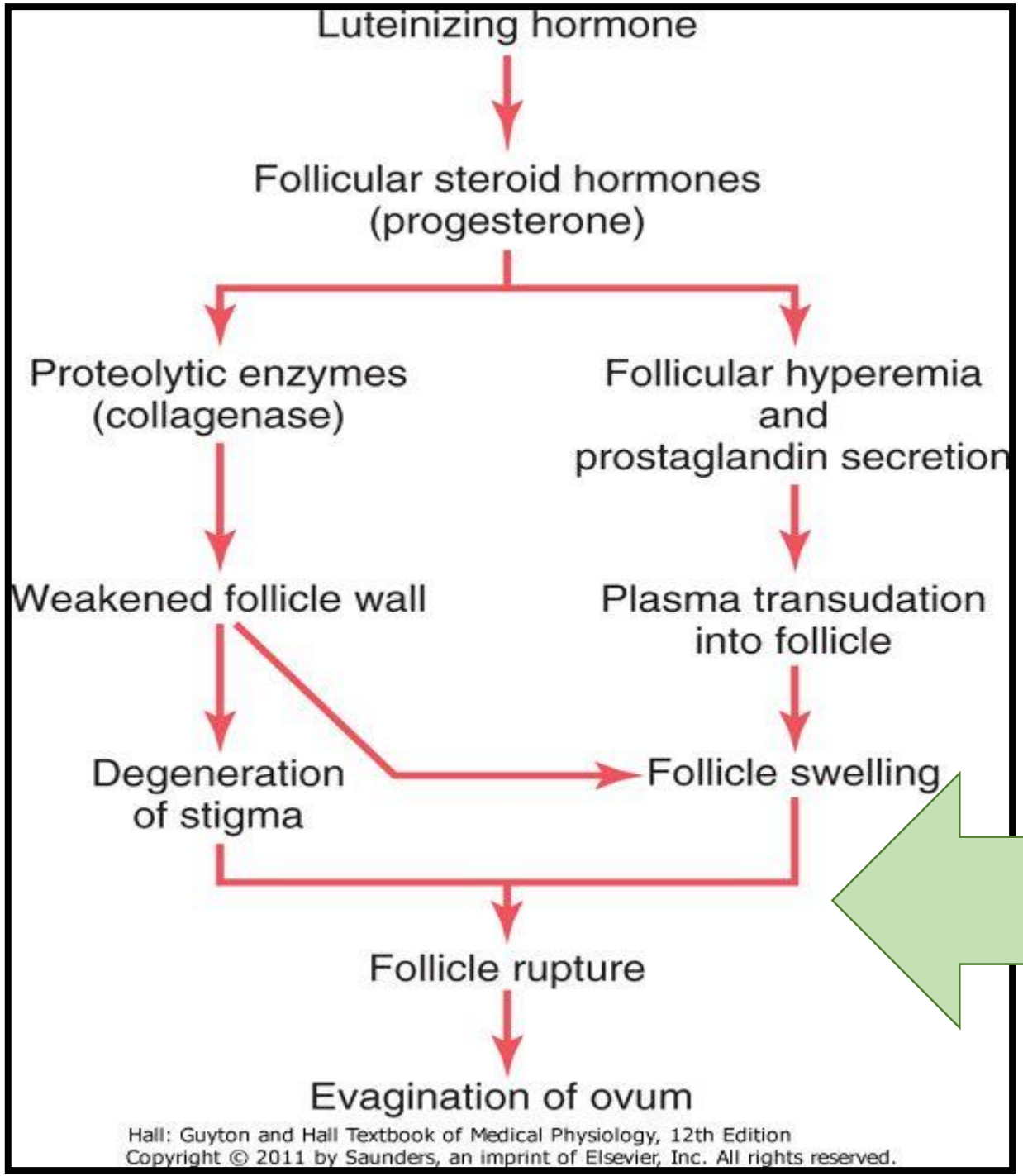


Rupture of the Graafian Follicle with Liberation of Ovum

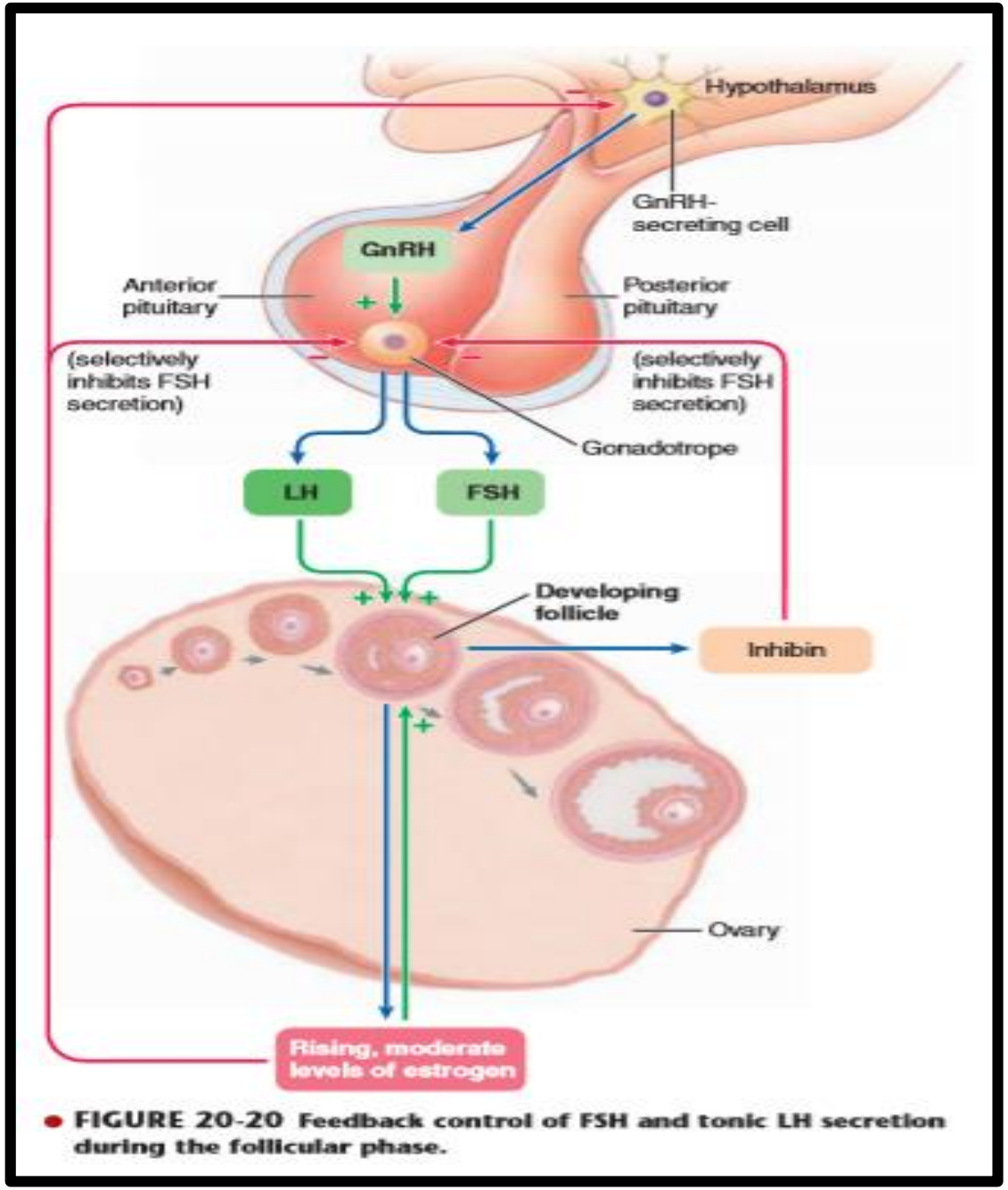


Ovulation

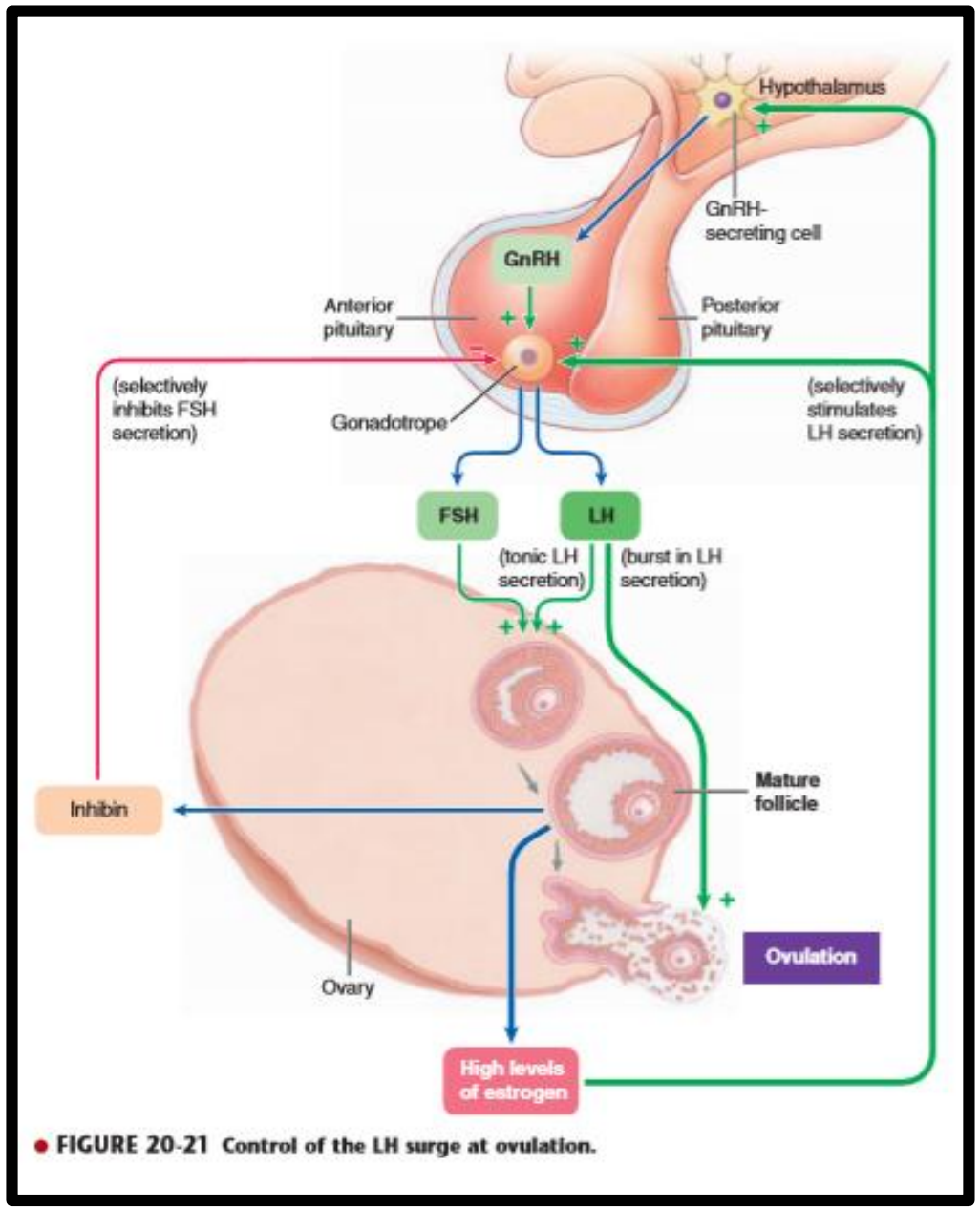
Mechanism of Ovulation



↑ Follicular Growth
+
↓Estrogen
+
Initiation of Progesterone

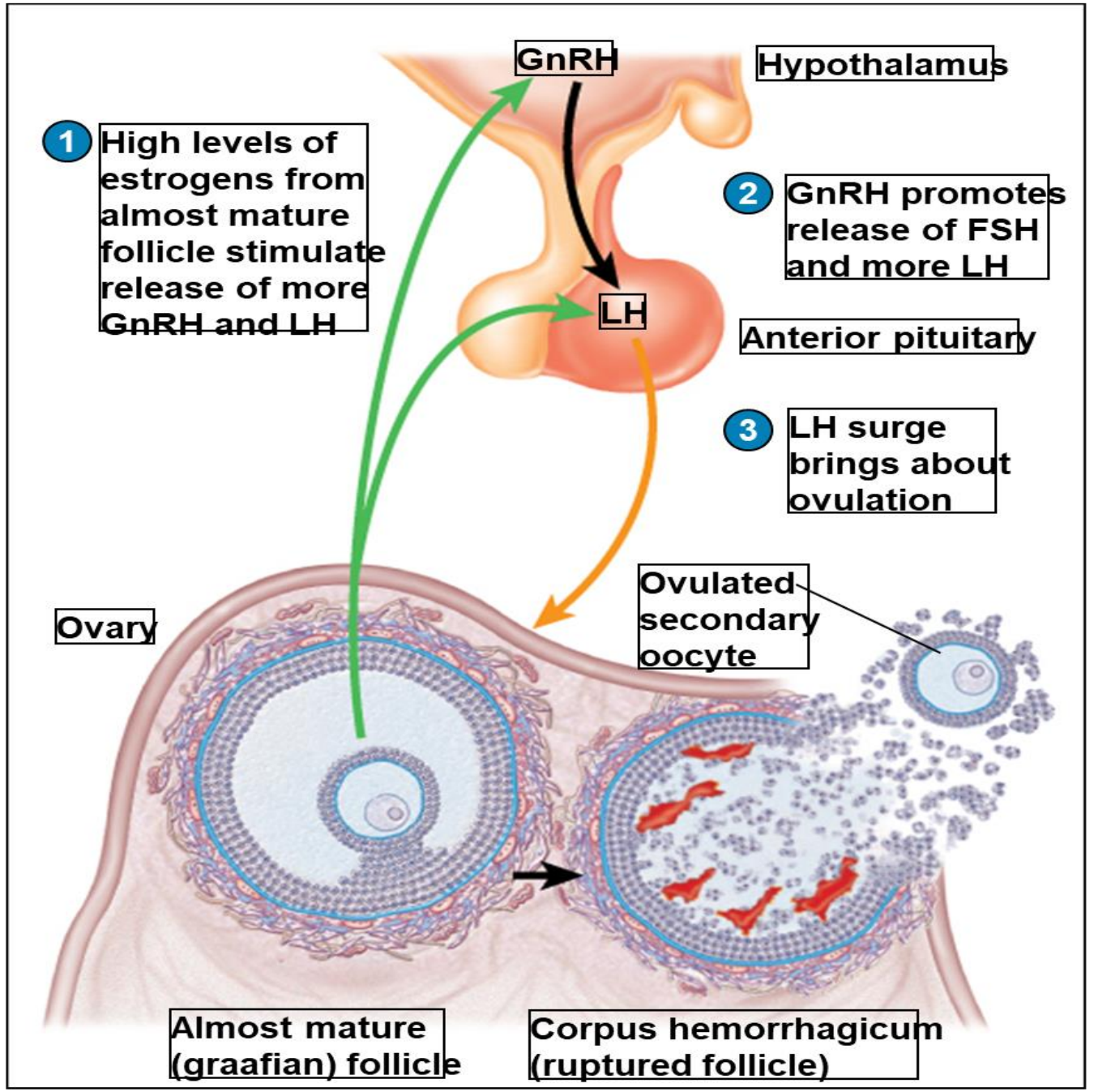


● **FIGURE 20-20** Feedback control of FSH and tonic LH secretion during the follicular phase.



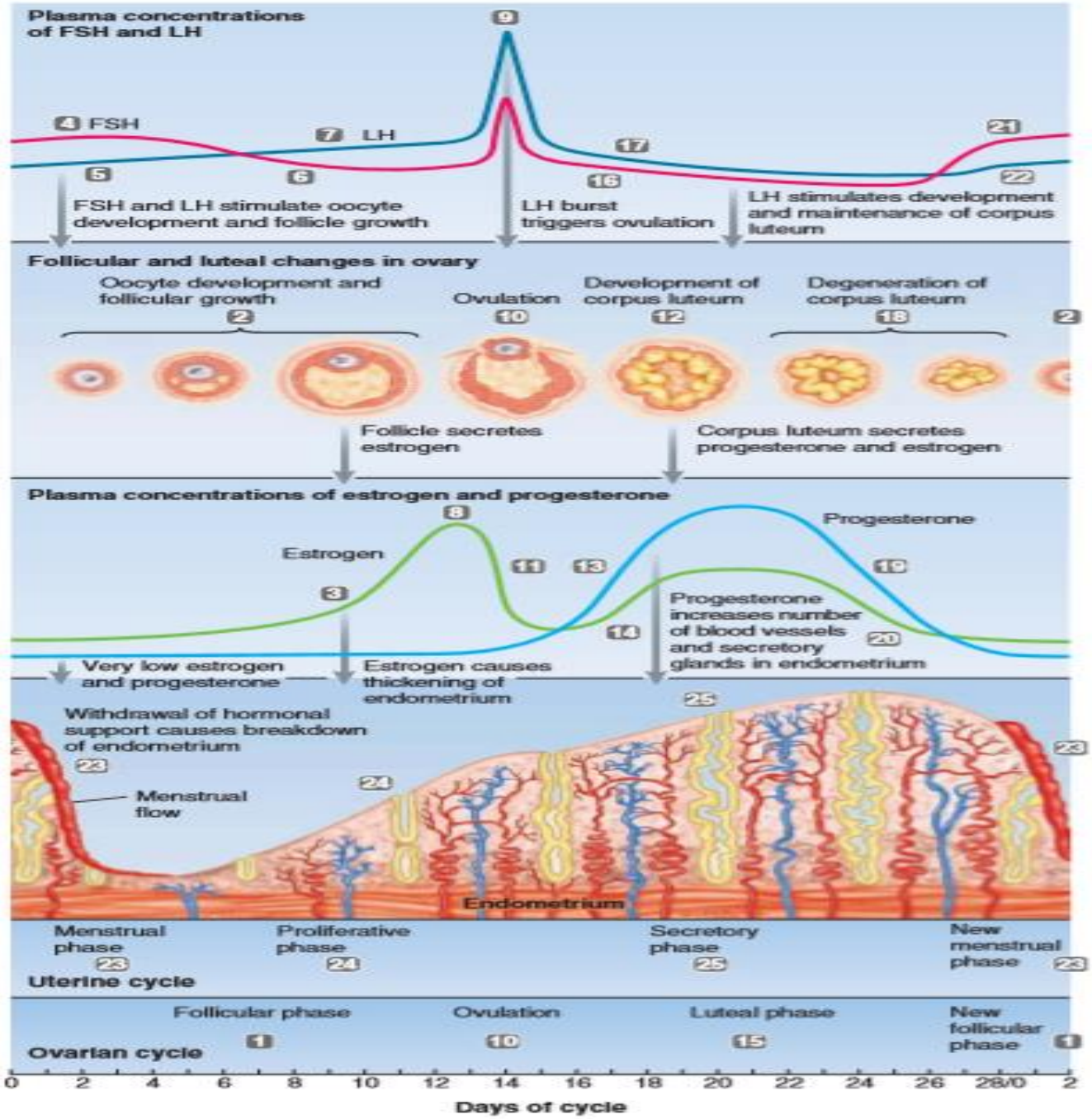
● **FIGURE 20-21** Control of the LH surge at ovulation.

Mechanism of Ovulation



Plasma Concentrations of FSH and LH

Plasma Concentrations of Estrogens and Progesterone



Summary of Causes of ovulation

1- The sharp increase in LH from anterior pituitary

2- Local weakness and degeneration of the ovarian surface

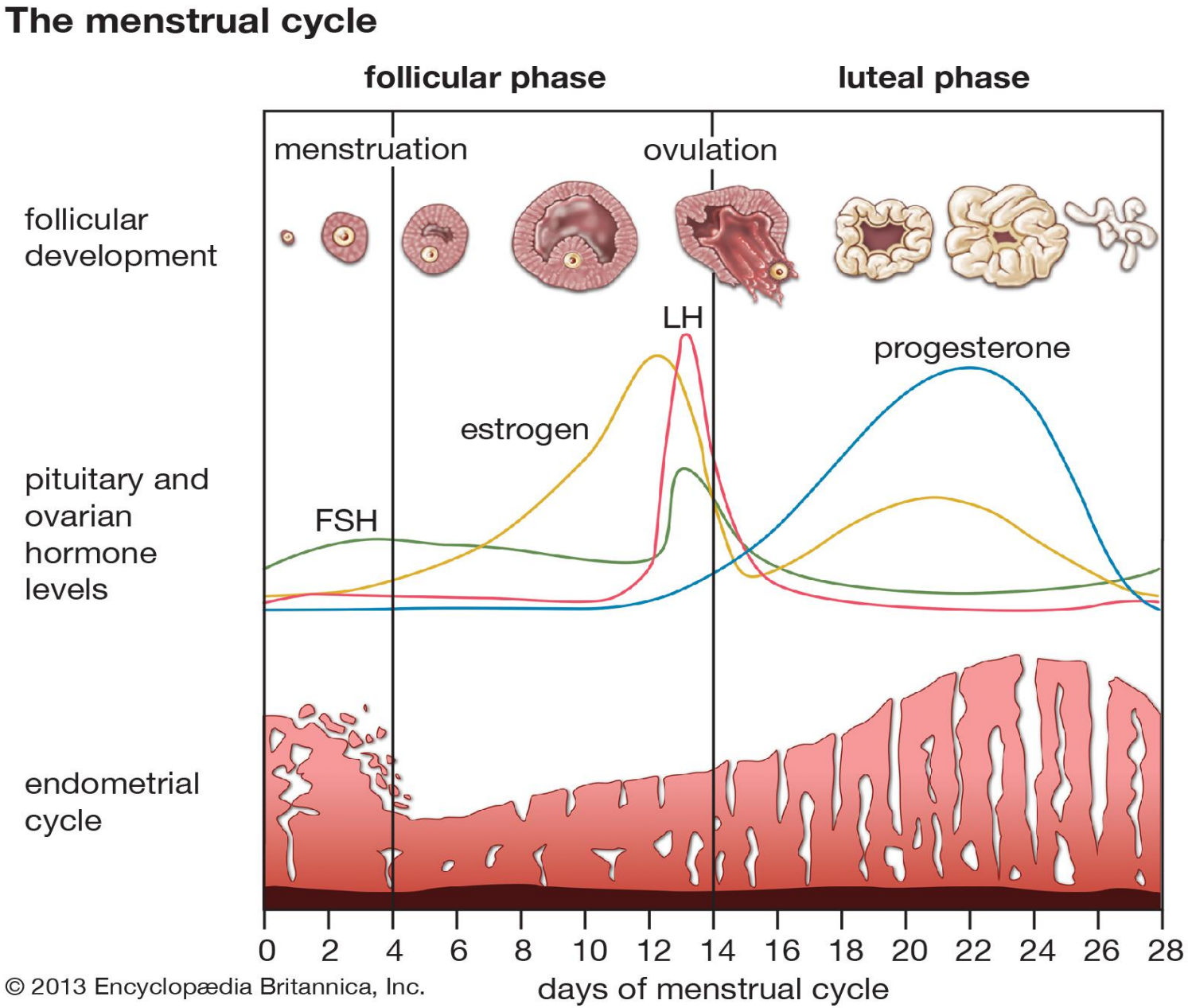
3- The increased intrafollicular pressure

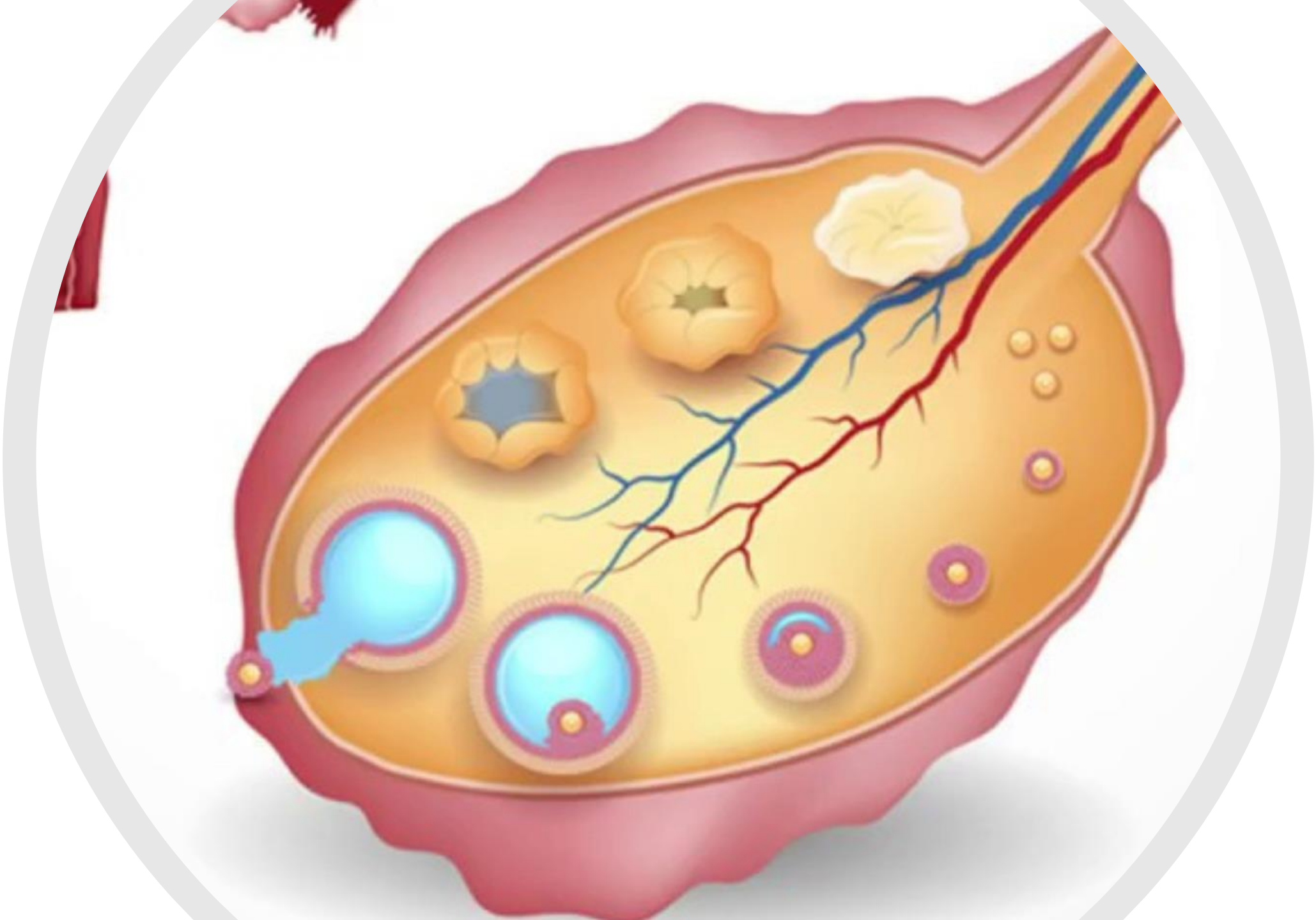
4- Muscular contraction of the ovarian wall

The Luteal Phase

Yellowing

The Luteal Phase





Fate Of Corpus Luteum

If Fertilization does not occur → Corpus Luteum → Corpus albicans

If Fertilization occurs → Pregnancy

Luteal Phase of Ovarian Cycle

Duration most constant of phases

Lasts for 14 days in 28 days cycle (day 15-28)

After ovulation, mature follicle collapses to form corpus luteum under the influence of LH

- **Corpus luteum grows to 1.5cm after 7/8 days**
- **Secretes Progesterone, Estrogen, Relaxin and Inhibin**
- **Growth of corpus Luteum depends on Vascular Endothelial derived Growth Factor (VEGF)**

Relaxin relaxes the ligaments of pelvis & softens the cervix

Inhibin inhibits FSH secretion by anterior pituitary

Function of Luteinizing Hormone

Corpus luteum secretes excess of estrogen and progesterone

LH surge causes theca and granulosa cells luteinization and these cells undergo

1. Proliferation
2. Enlargement
3. Secretion
4. Degeneration

No Fertilization-Involution of Corpus Luteum (24th Day) → Corpus Albicans

If Pregnancy occurs, Corpus Luteum Persists and no mensus

- **Granulosa cells** in corpus luteum produce estrogens and more progesterone

- Theca cells form mainly the androgens androstenedione and testosterone rather than female sex hormones, but they are converted by **AROMATASE** enzyme → estrogens

The Monthly Endometrial Cycle

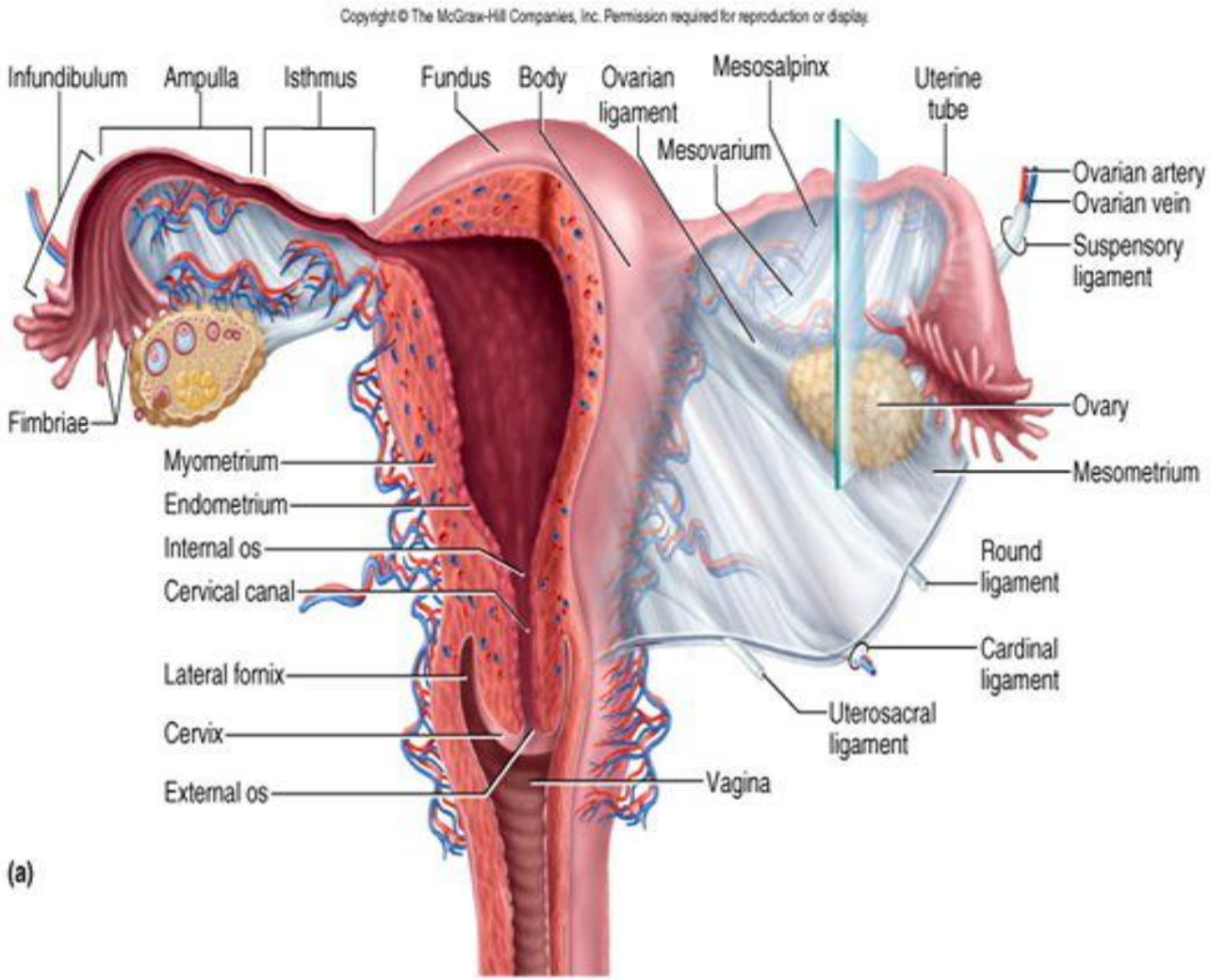
Cyclic changes in the Endometrium every 28 days

under the control of Ovarian hormones

Uterine Cycle and Menstruation

- Cyclical changes in uterus → menstrual bleeding once during each menstrual cycle
- Lasts about 5-7 days after degeneration of corpus luteum

Uterine Wall



- Uterine Wall is composed of three layers
  - Perimetrium – outermost serous layer; the visceral peritoneum
  - Myometrium – middle layer; interlacing layers of smooth muscle
  - Endometrium – mucosal lining of the uterine cavity changes in thickness during the menstrual cycle

The Menstrual Phase

The Menstrual Phase

discharge of blood and endometrial debris form vagina

start of a new Ovarian cycle coinciding with the end of luteal phase and onset of the follicular phase

First day of menstruation is considered start of a new cycle

Degeneration of corpus luteum

Decreased level of estrogen and progesterone

Decreased Ovarian hormones stimulate Prostaglandin release

Prostaglandin causes Vasoconstriction of endometrial vessels →disrupting blood supply to endometrium

Bleeding along with the Endometrial debris from the Uterine cavity is known as Menstruation

The Menstrual Phase

Involution of endometrium to 65% of thickness

Vasospasm of tortuous blood vessels and decreased nutrients

→ Necrosis in Endometrium → Menstruation (40 ml Blood + 35 ml Serous Fluid)

Blood, Desquamated endometrium, cervical mucus, vaginal cells

Does all the Uterine lining gets sloughed off during Menstruation?

Uterine lining mostly sloughs during each period except for a deep thin layer of epithelial cells and glands → regeneration of endometrium

The Menstrual phase

Local uterine prostaglandin stimulates mild rhythmic contractions of the uterine myometrium

The contractions help expel the blood and endometrial debris from the uterine cavity out through the vagina as Menstrual Flow

↑ uterine contractions by prostaglandin overproduction → the menstrual cramps (Dysmenorrhea)

Blood does not clot due to **Fibrinolysin** released with necrotic material

Uterine contractions are initiated by **Prostaglandins** and other substances in desquamated material

Within 4-7 days the blood loss stops due to **re-epithelialization**

The Menstrual Phase

- Average blood loss during a cycle

50-150 mL

- Menstrual blood flow

Has large number of Leukocytes – **Leukorrhea** so resistant to infection

The Proliferative Phase of Endometrial Cycle

The Proliferative Phase (Estrogen)

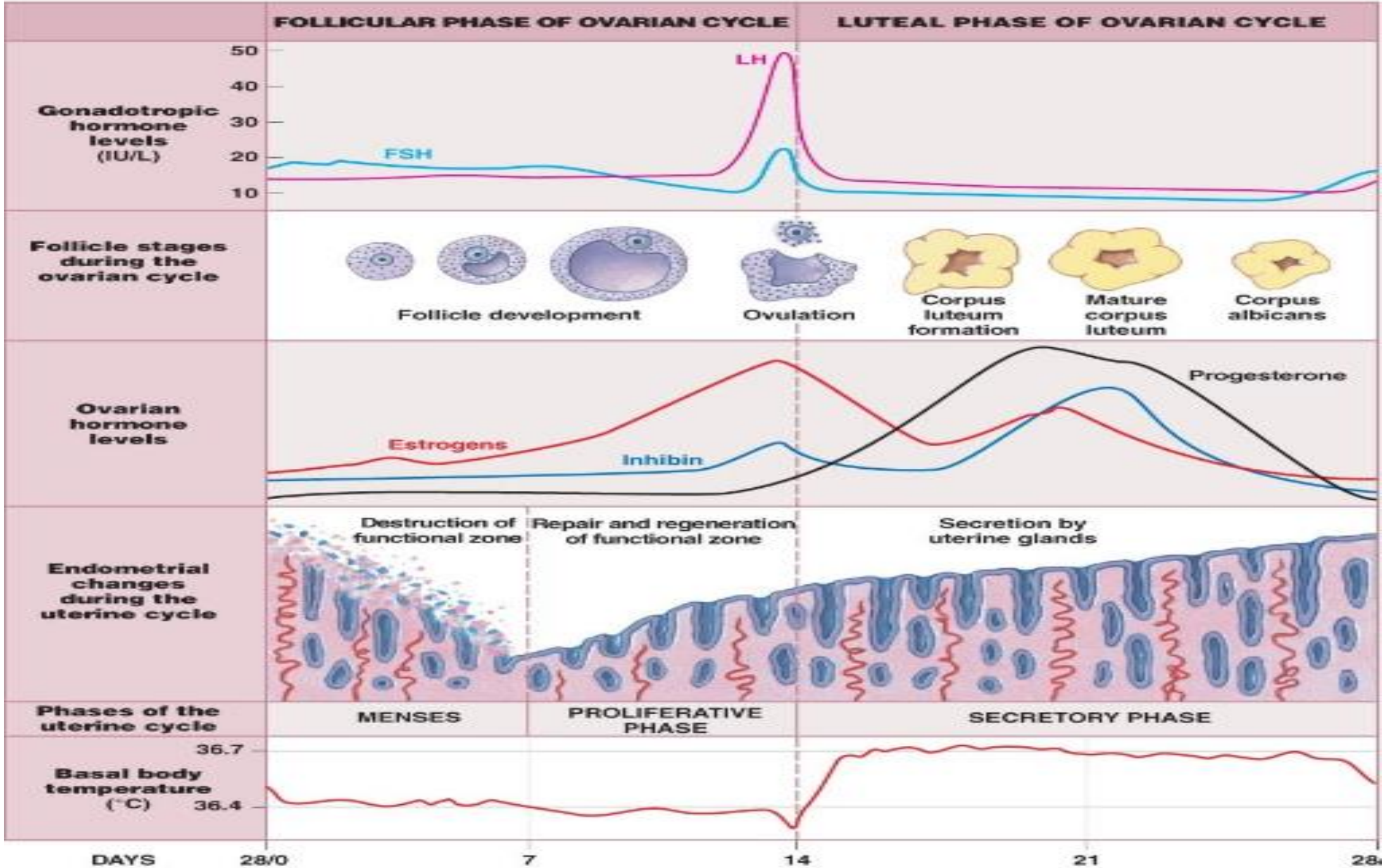
After menstruation only thin endometrium is left

Estrogens → Endometrium ↑ in thickness

Re-epithelialization in 4-7 days after start of menstruation

By the time of ovulation endometrium is 3-5 mm thick

Endometrial glands especially of cervical region secrete mucus that guides sperm to enter the into uterus tortuous & rich of mucin, glycogen


FOLLICULAR PHASE OF OVARIAN CYCLE
LUTEAL PHASE OF OVARIAN CYCLE
Gonadotropic hormone levels (IU/L)
50
40
30
20
10
LH
FSH
Follicle stages during the ovarian cycle
Follicle development
Ovulation
Corpus luteum formation
Mature corpus luteum
Corpus albicans
Ovarian hormone levels
Progesterone
Estrogens
Inhibin
Endometrial changes during the uterine cycle
Destruction of functional zone
Repair and regeneration of functional zone
Secretion by uterine glands
Phases of the uterine cycle
MENSES
PROLIFERATIVE PHASE
SECRETORY PHASE
Basal body temperature (°C)
36.7
36.4
DAYS
28/0
7
14
21
28

Secretory Phase/ Progestational phase

Secretory Phase/ Progestational phase

Corpus luteum secretes Progesterone and Estrogens

- **Progesterone → swelling and secretory development of endometrium (glands, lipid & glycogen deposit, ↑blood flow)**

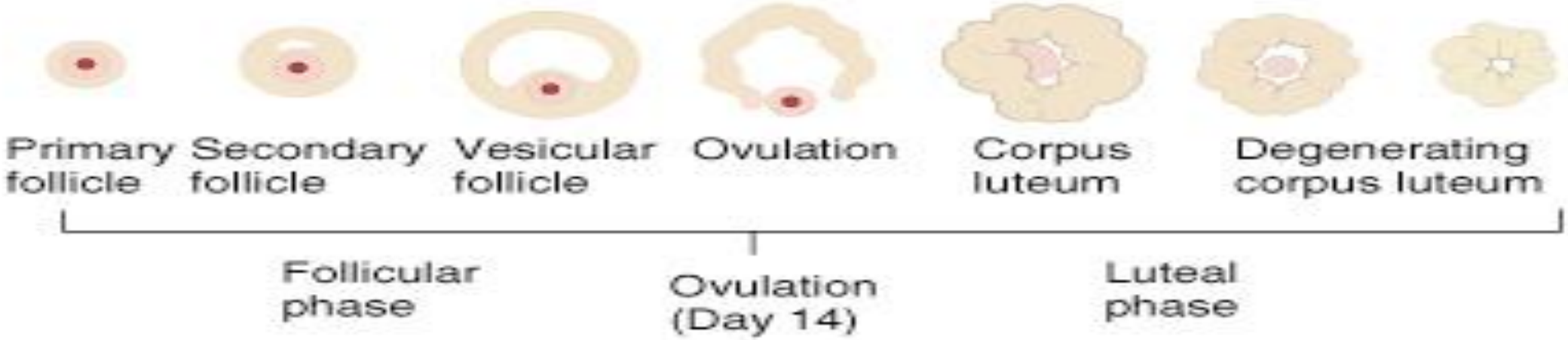
- **Estrogens → slight cellular Proliferation in Endometrium**

Highly Secretory Endometrium for Implantation of Fertilized Ovum

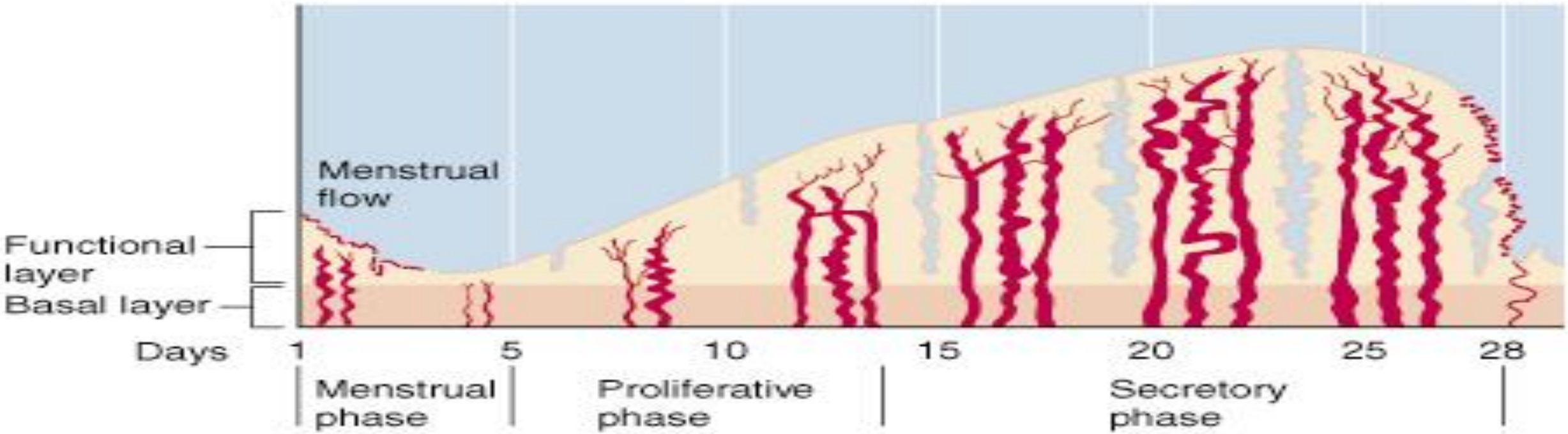
Secretory or Progestational Phase

- 1 week after ovulation endometrial thickness is **5-6mm**
- Appropriate conditions for fertilized ovum
- **Uterine Milk** provides nutrition

- Once ovum implants it gets nutrition from rich endometrium



(c) Ovarian cycle



(d) Uterine cycle

Summary of Endometrial Cycle

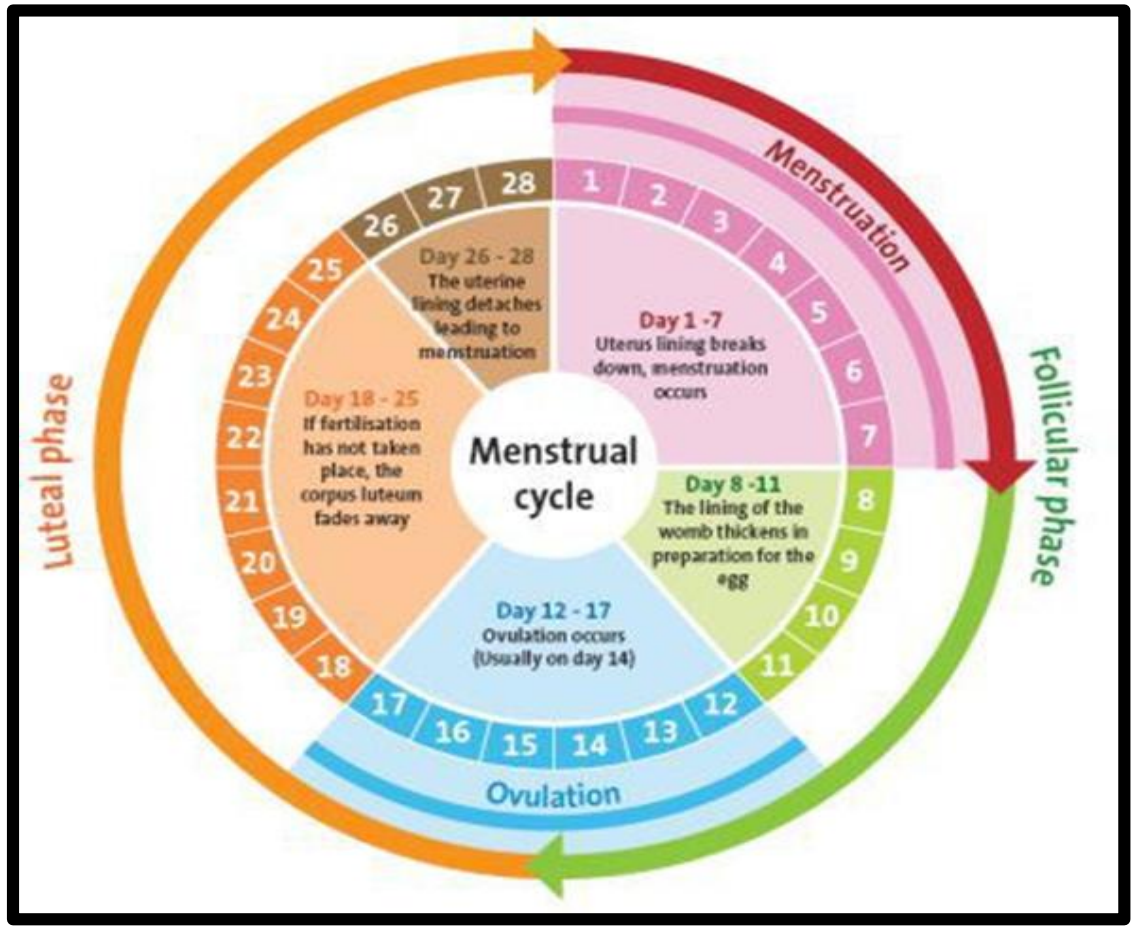
Ovarian Estrogen

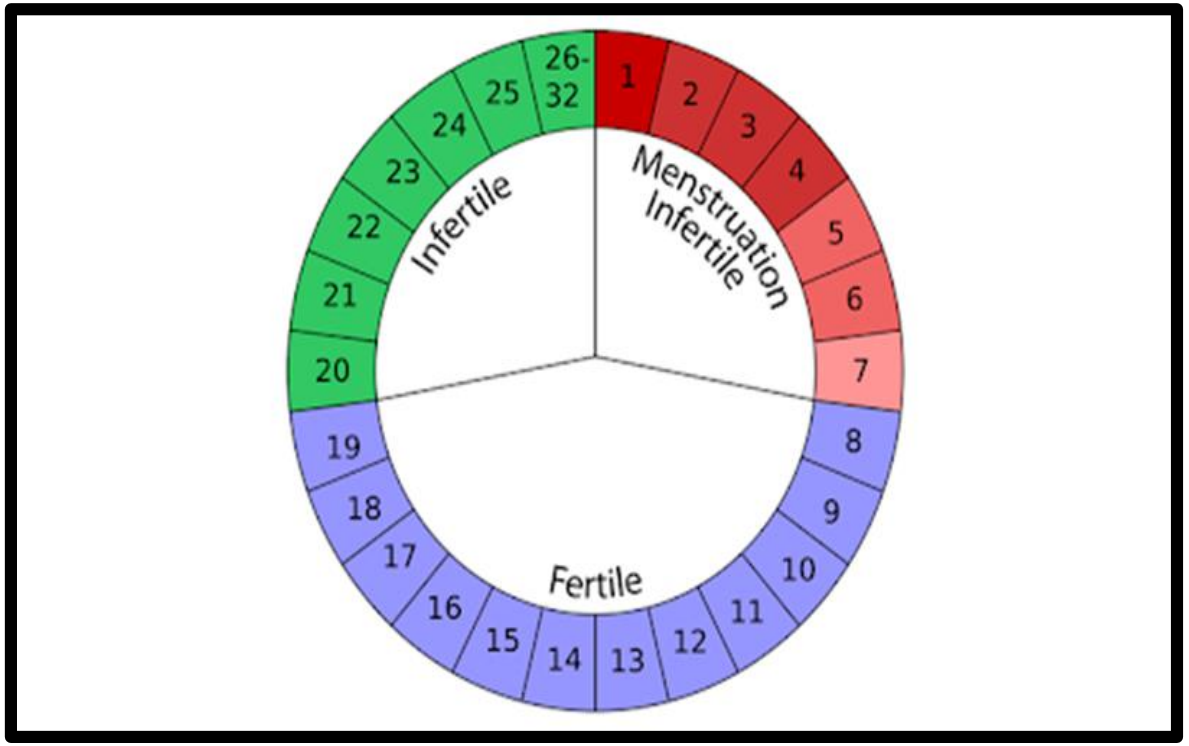
14 Days

PGs

Proliferative Phase	**↑ No of Stromal Cells** **↑ Growth of Endometrial Glands** **Mucus** **Endometrial thickness is 3-5 mm at ovulation**
Secretory Phase Estrogen & Progesterone	**Cellular Proliferation** **Glands increase in tortuosity** **↑ Lipid & Glycogen in glandular cells** **Blood flow ↑** **Endometrial thickness is 5-6 mm**
Menstrual Phase	**No fertilization** **Corpus Luteum involutes** **↓Estrogen and Progesterone** **Involution of Endometrium** **Spasm of Blood vessels** **Blood + Desquamated tissue + PGs** **40 ml blood + 35ml Serous fluid**

Summary


Menstruation
Follicular phase
Ovulation
Luteal phase
Menstrual cycle
Day 1 -7
Uterus lining breaks down, menstruation occurs
Day 8 -11
The lining of the womb thickens in preparation for the egg
Day 12 - 17
Ovulation occurs (Usually on day 14)
Day 18 - 25
If fertilisation has not taken place, the corpus luteum fades away
Day 26 - 28
The uterine lining detaches leading to menstruation


Infertile
Menstruation
Infertile
Fertile
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Regulation of Female Monthly Rhythm

Hypothalamus (Arcuate nuclei, preoptic area, anterior part) secretes Gonadotropin Releasing Hormone (Intermittent Pulsatile)

Intermittent Pulsatile Release of FSH & LH From Anterior Pituitary

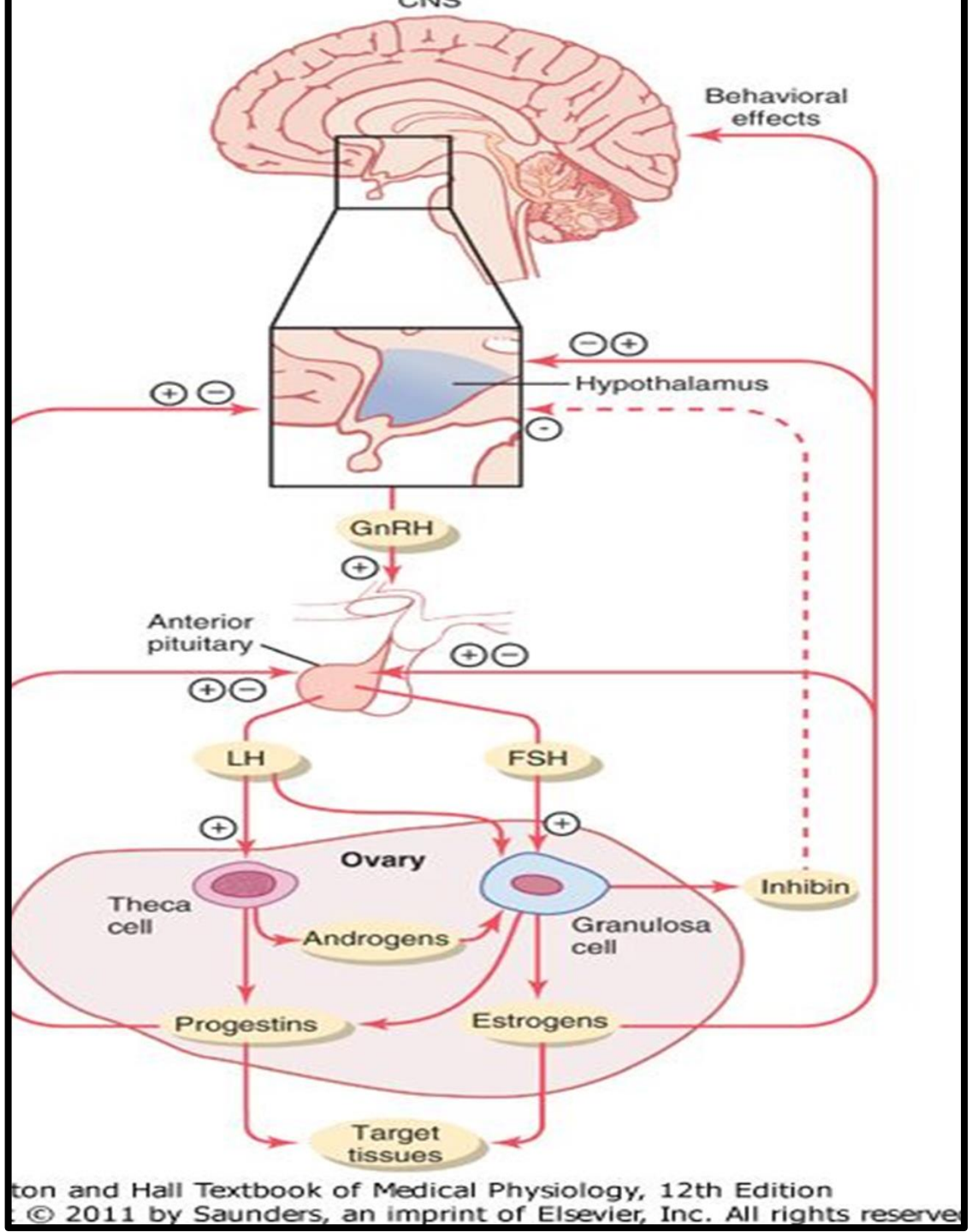
Negative feedback to ↓ FSH LH by Estrogen in small amounts & Progesterone

Inhibin (Corpus Luteum Granulosa Cells)

Positive Feedback Effect of Estrogen & Progesterone before OVULATION

The Preovulatory LH Surge

Feedback Oscillation of Hypothalamic Pituitary Ovarian Axis



Feedback Oscillation of Hypothalamic Pituitary Ovarian Axis

Sequence of Events

Post ovulatory secretion of Ovarian Hormones and ↓ of Pituitary Gonadotrophins

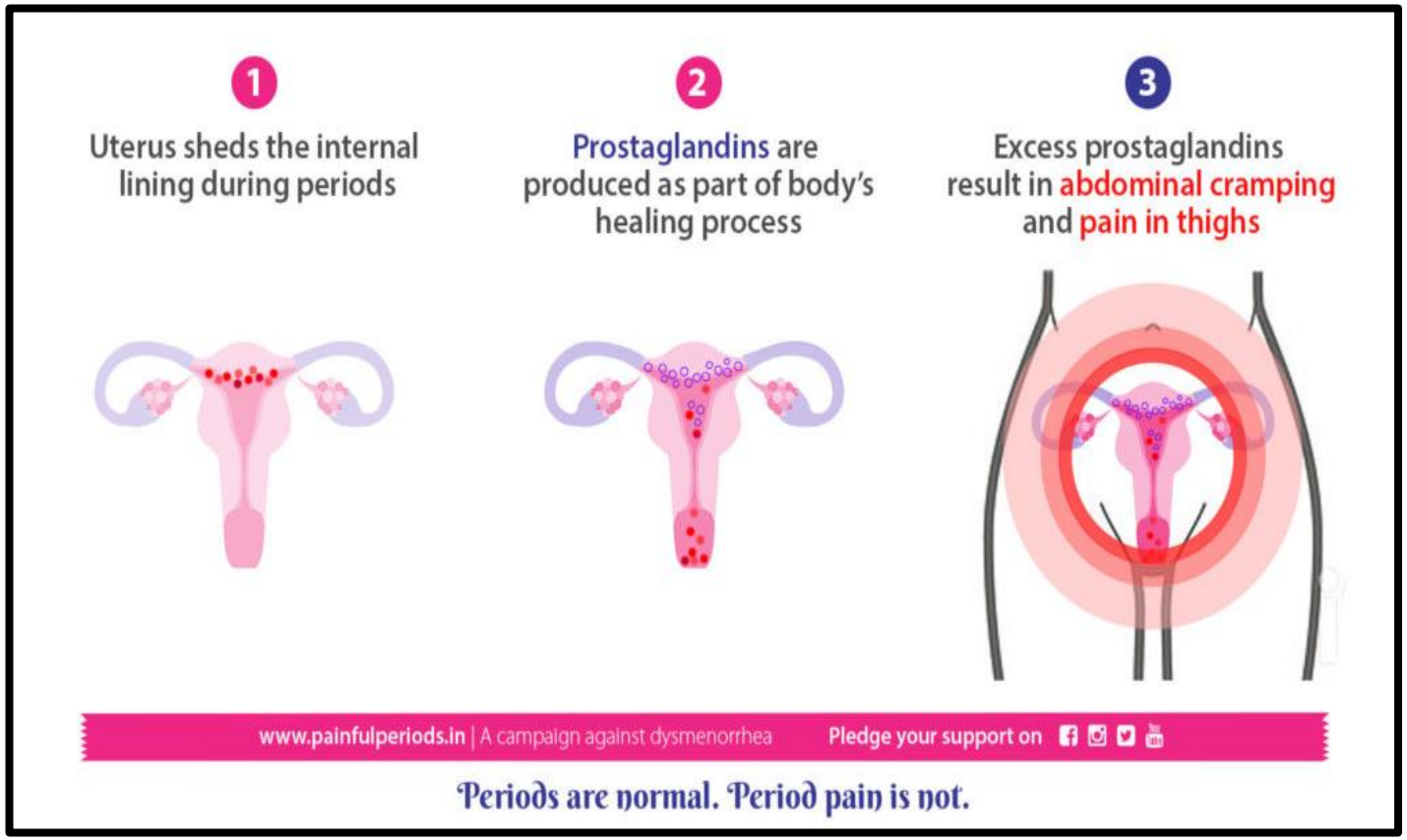
Follicular Growth Phase → Corpus Luteum shrinks before menstruation and estrogen, progesterone & Inhibin ↓ leading to ↑ in FSH

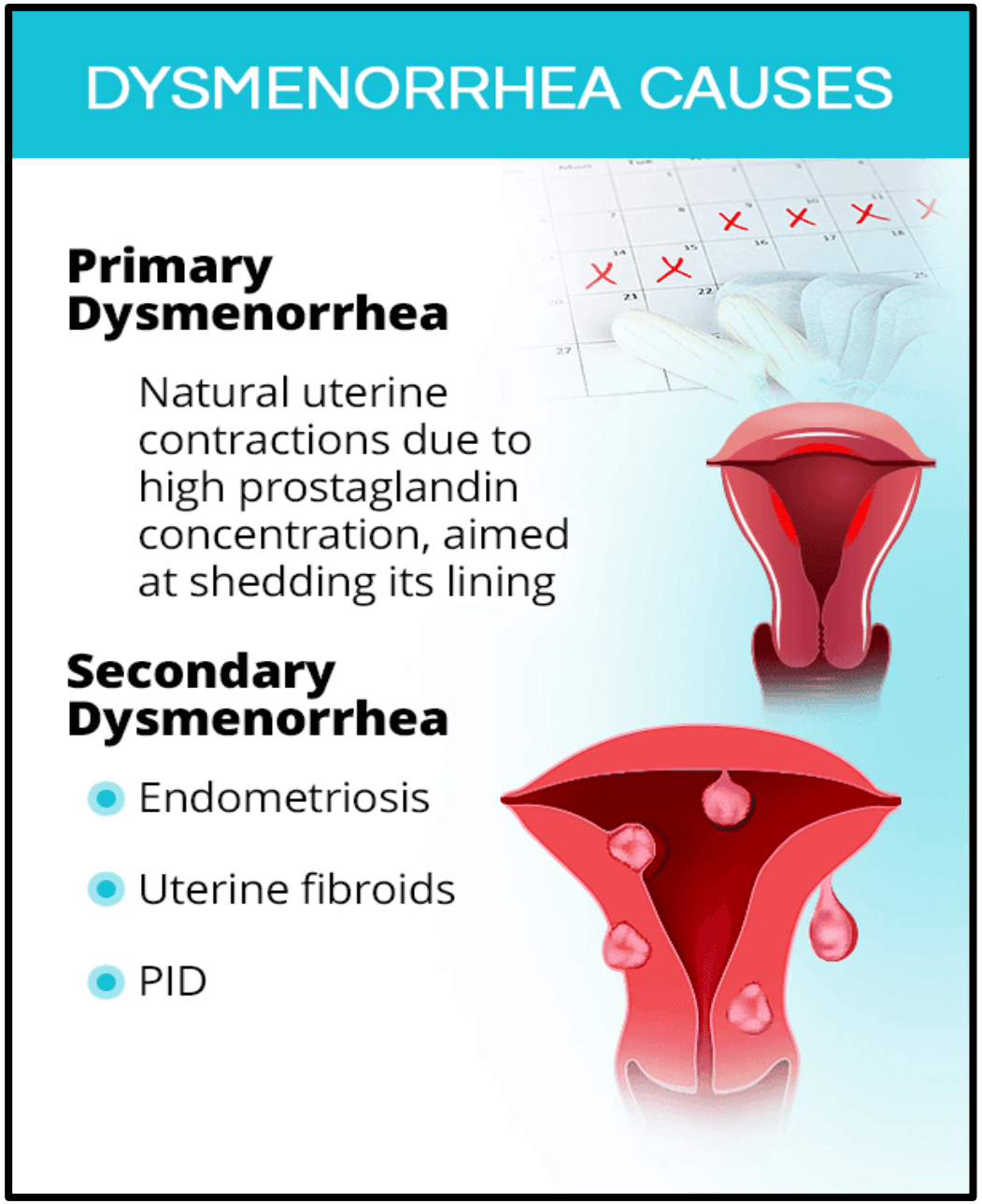
The **Preovulatory Surge** of FSH & LH causes Ovulation. ↑ LH Leads to Ovulation and Corpus Luteum

Anovulatory Cycles

- **At puberty and before menopause**
- **If the preovulatory surge of LH is not of sufficient magnitude, ovulation will not occur → Anovulatory**
- **Lack of ovulation → no corpus luteum & no progesterone in latter part of cycle**
- **Cycle is shortened but rhythm continues**

Menstrual Pain





Unexpected Causes of Irregular Periods

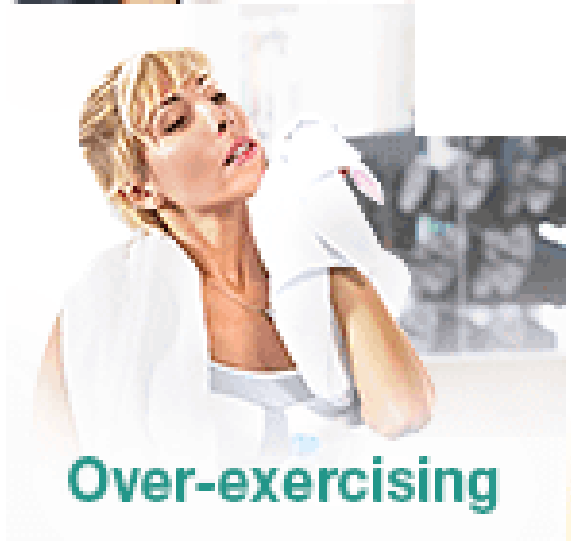
Extreme weight change

Breastfeeding

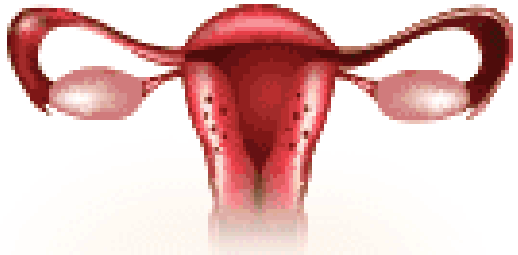
Medications

Pregnancy

Thyroid malfunction



Over-exercising



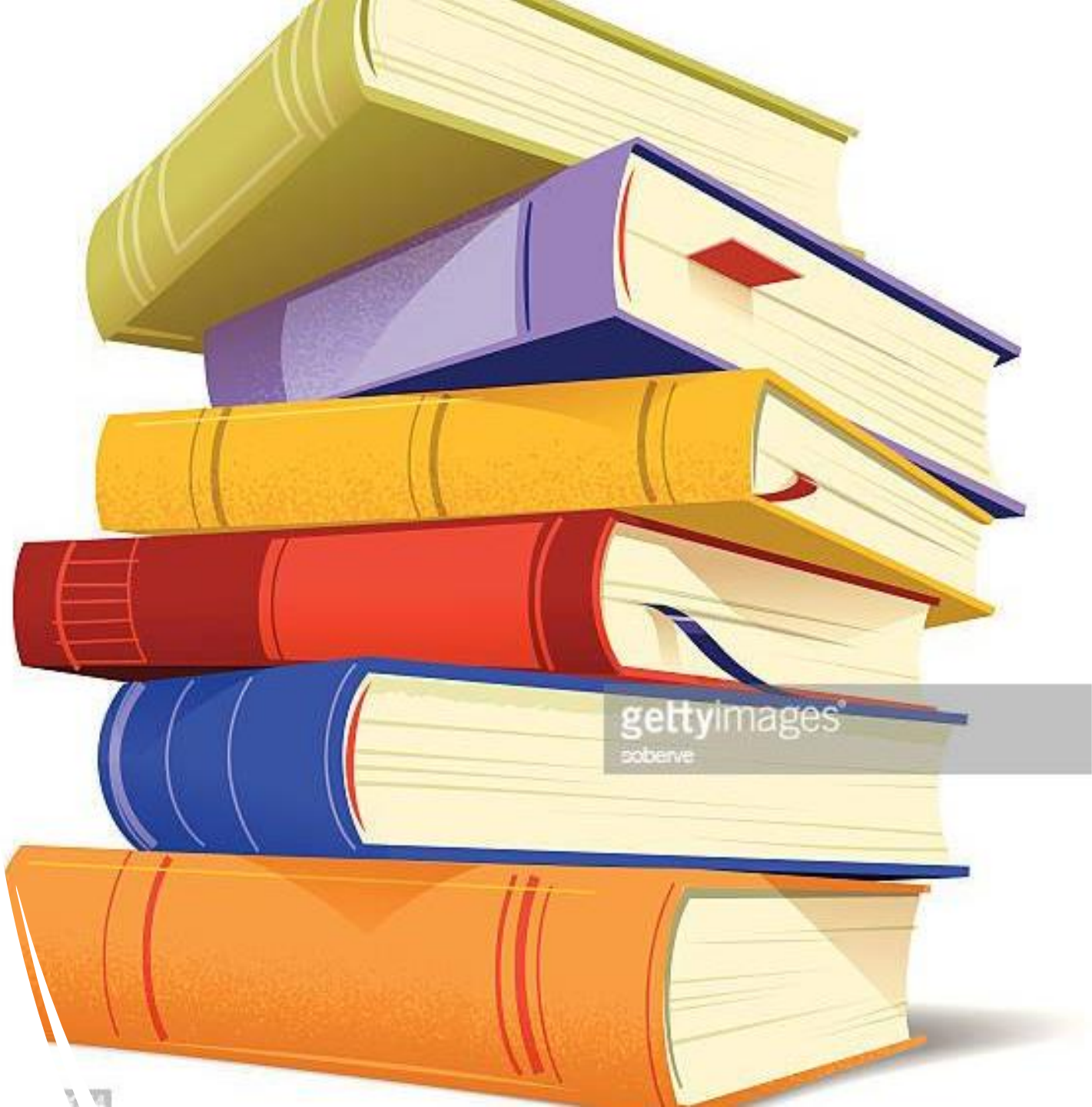
Problems with reproductive organs

Contraception

Stress

References

- Guyton and Hall
- Sherwood Physiology
- Berne and Levy Physiology
- Encyclopedia Britannica



Any questions ?


Thank You