Female Reproduction
&
Its Hormonal Control

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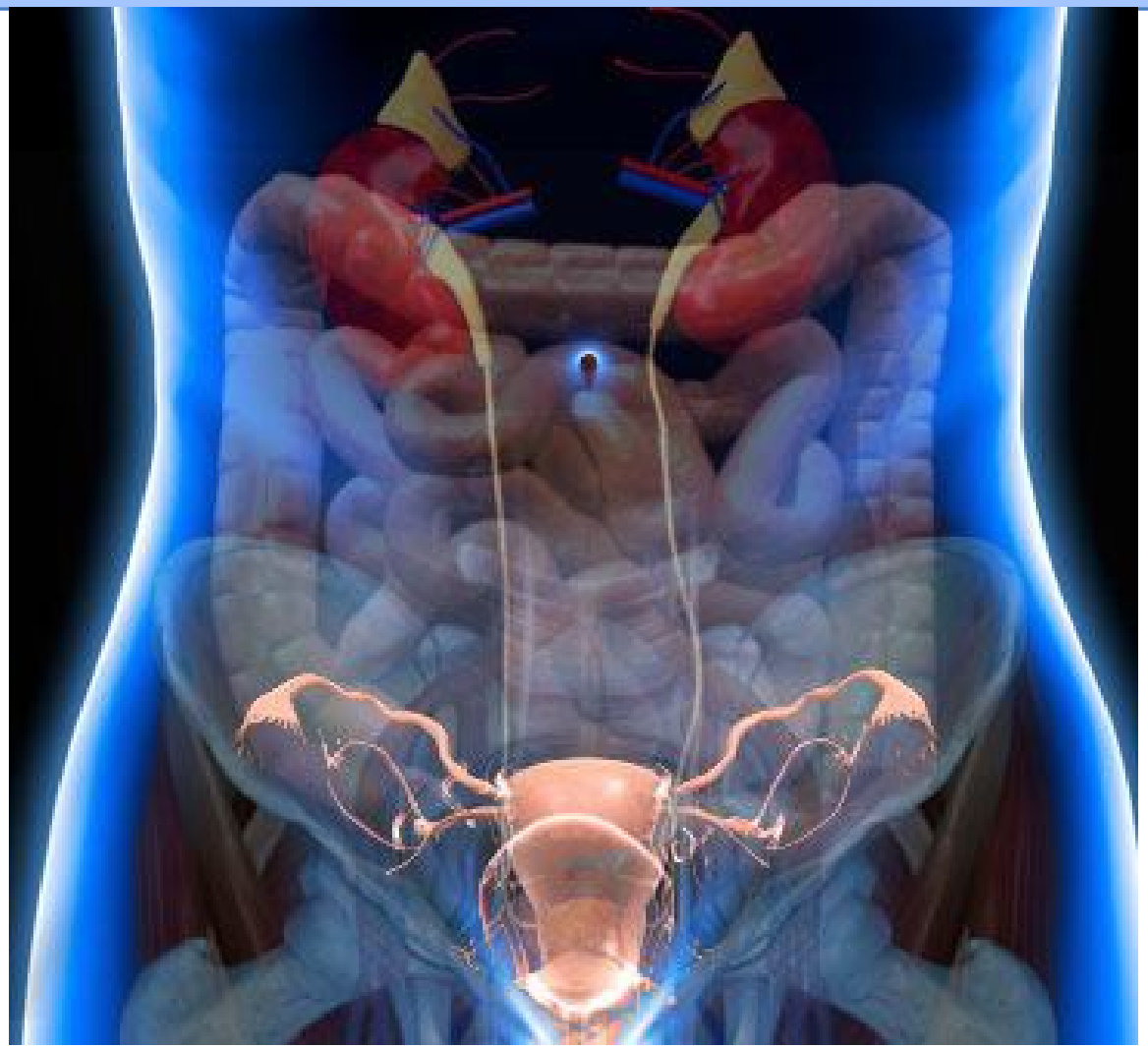
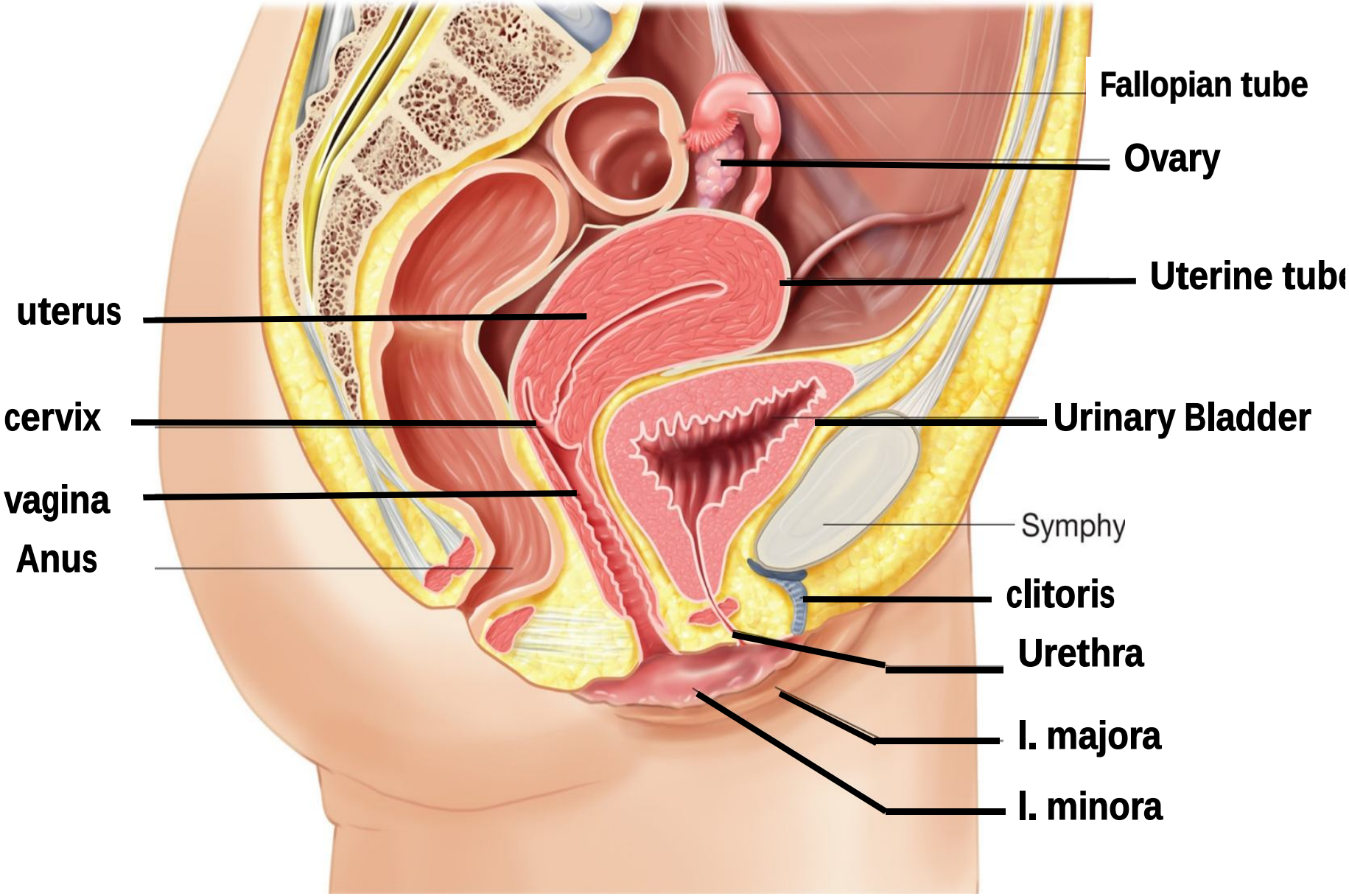
Female Reproductive System

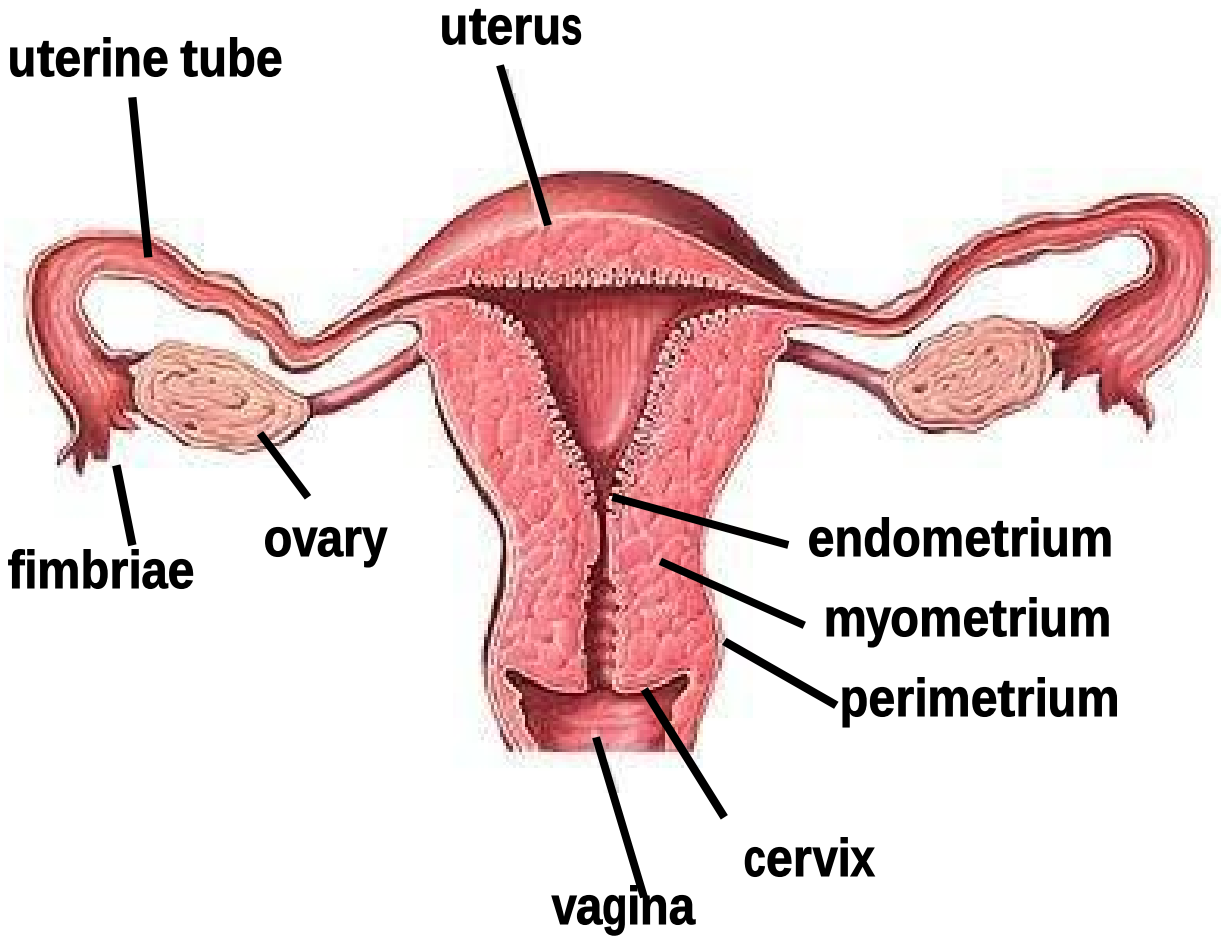


Female Reproductive System



Internal reproductive Structure:

- Vagina
- Cervix
- Fallopian tube (uterian tube/oviducts)
- Fimbrae
- Ovary
- Uterus
  - Endometrium
  - Myometrium
  - Perimetrium



Vagina

- Is about 8 to 10 cm long
- It extends from the exterior to the cervix
- It is the female copulatory organ

Cervix

•This is a narrow neck and is the outlet of the uterus into the vagina

* This is call the ***external os***

•The glands of the cervix lubricate the vagina and can block the entry of sperm unless it is at mid cycle

Uterus

@ Its function is to receive, retain and nourish the fertilized ovum.

@ The non pregnant human female uterus is the size of an inverted pear.

@ The rounded region superior to the entrance of the fallopian tubes is the fundus.

@ The portion between the fundus and the cervix is the body.

@ The uterus has three layers:

- **Endometrium**: mucosal lining of columnar epithelium
- **Myometrium**: layers of smooth muscle
- **Perimetrium**: incomplete serous layer

Uterine (Fallopian) Tubes

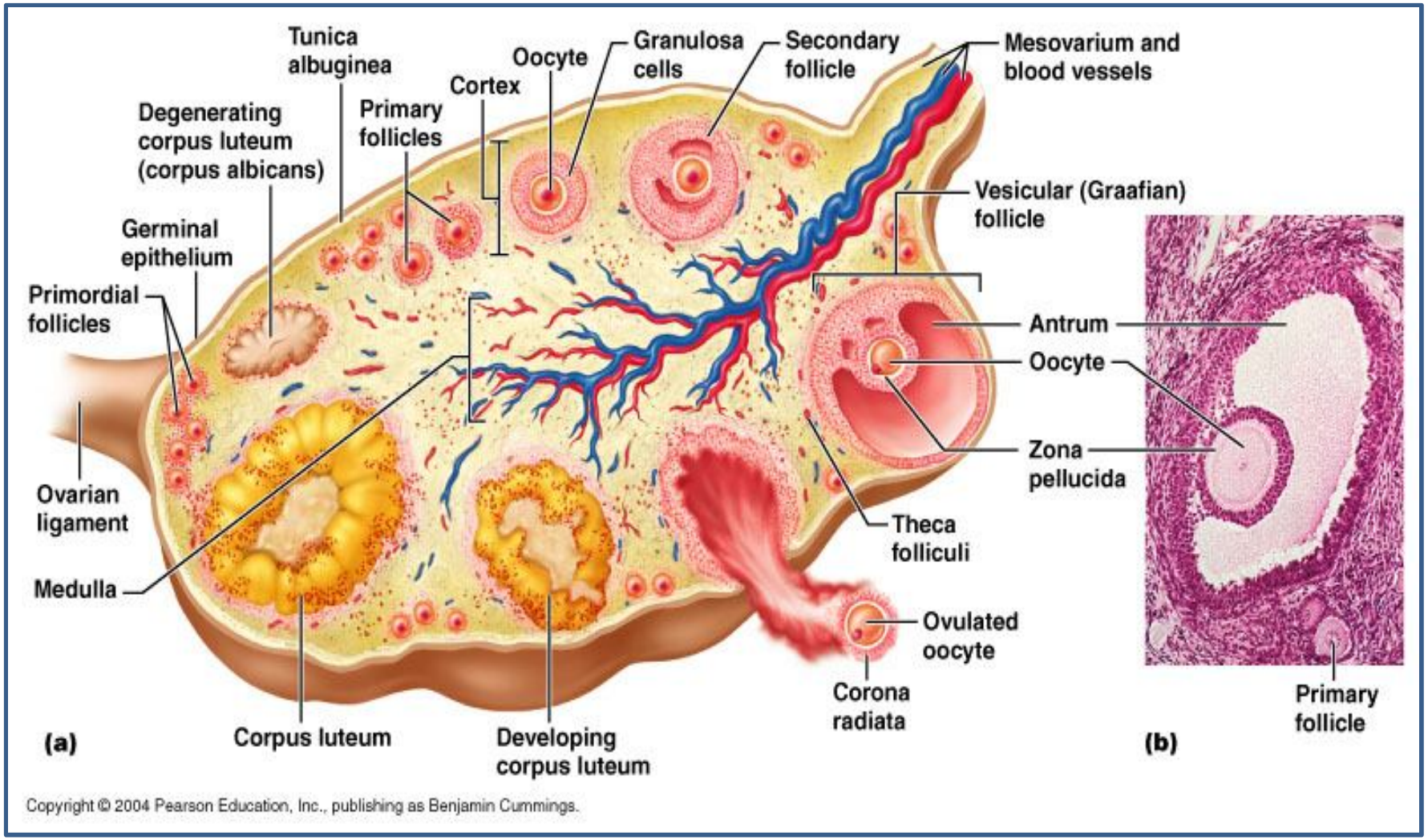
- Receive the ovulated oocyte
- Site of fertilization, the ampulla
- Fimbriae are finger like projections at the end of the oviduct
- Contains ciliated epithelium that draw the oocyte in
- 10 cm long

Fimbrae & Fallopian Tube

Ovary

- Anchored by the ovarian ligament
- Outwardly covered by the tunica albuginea
- Contains the ovarian follicles consisting of an oocyte and follicular cells
- Site of oocyte maturation

Oogenesis in the Ovary

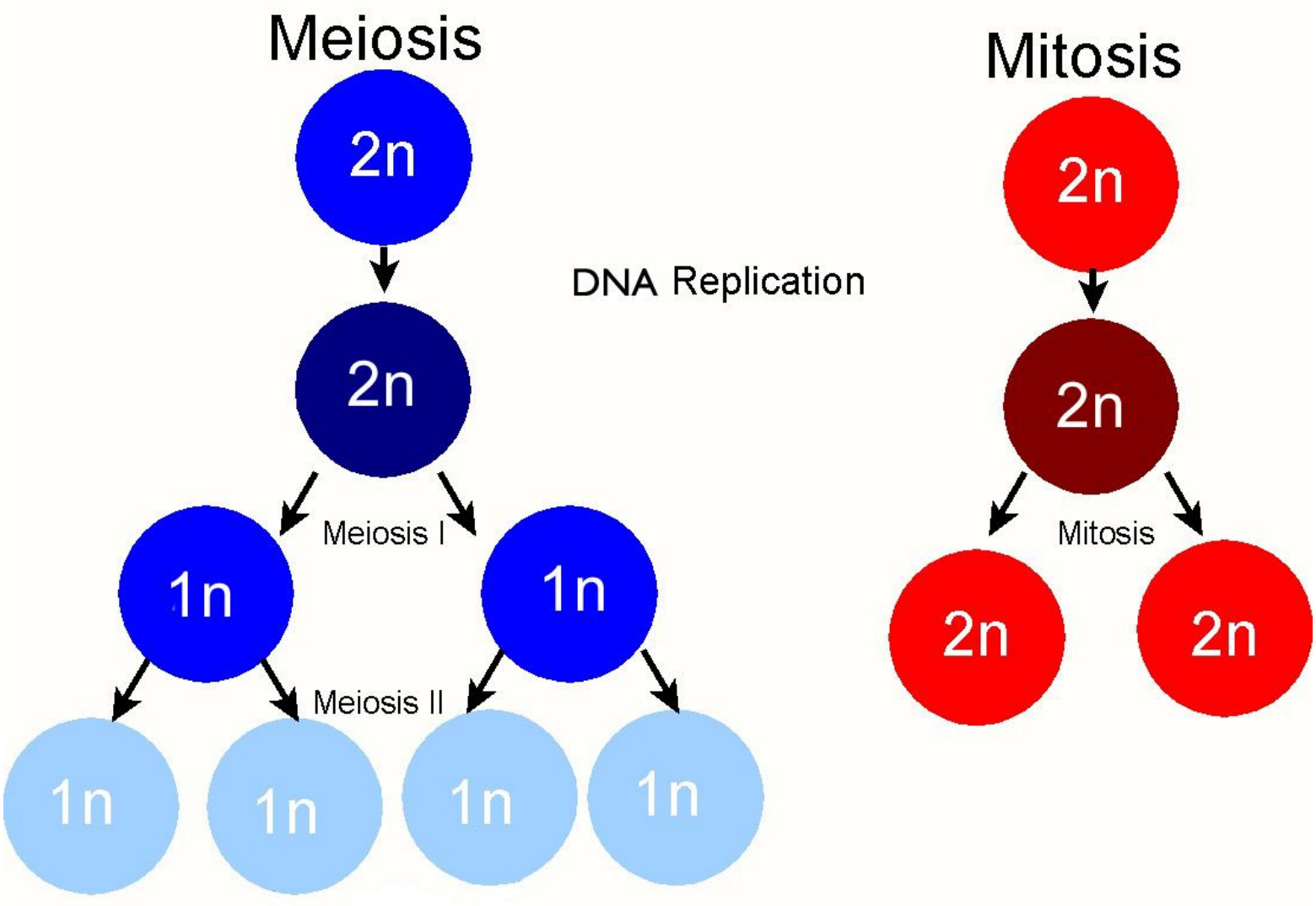


Oogenesis

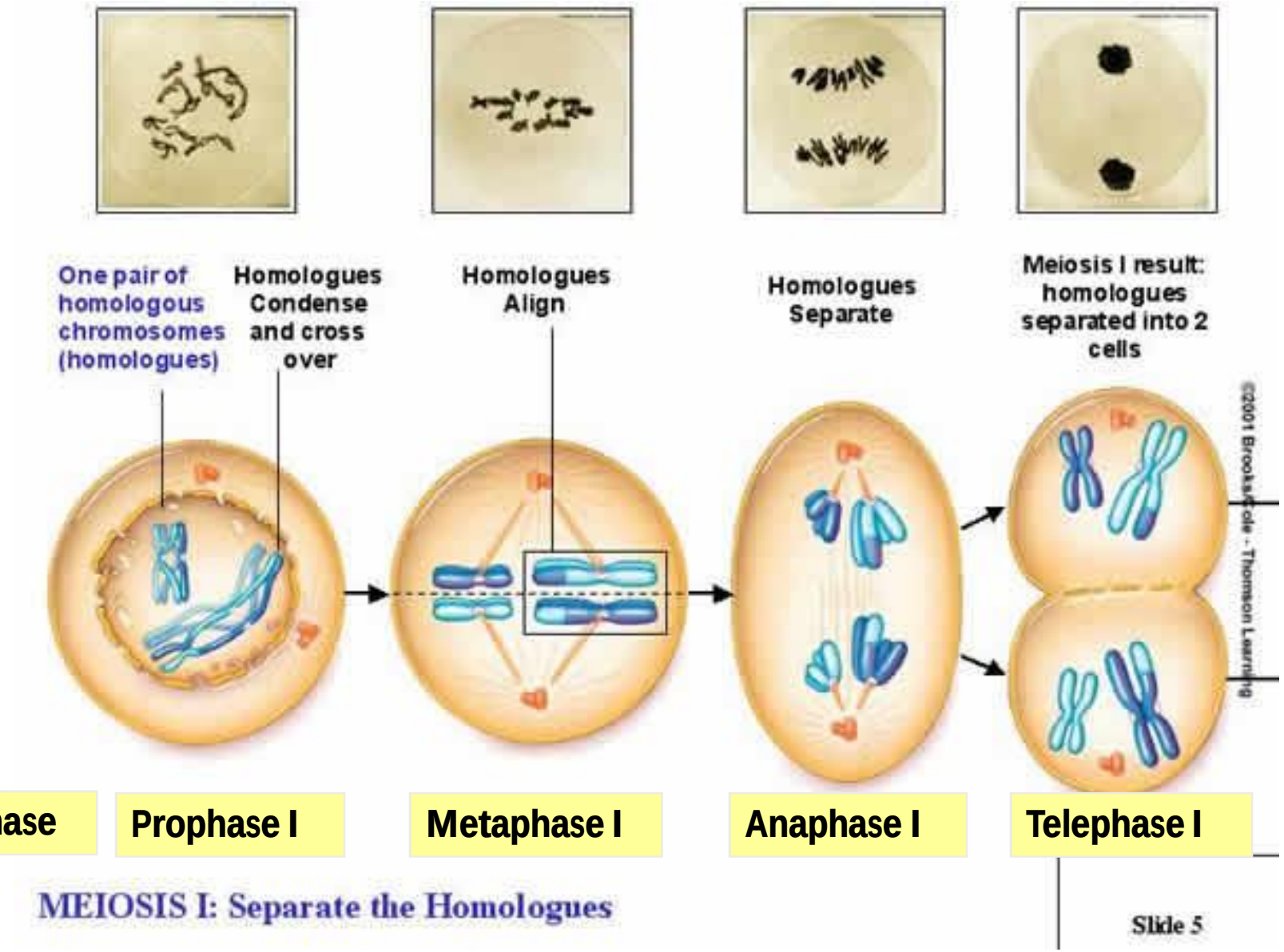
Ovary- contains 400,000 oocytes; release about 500 in a lifetime

- Ovary- under influence of FSH. The follicles mature every 28 days
- Primary follicle produces estrogens
- And primary oocyte completes its 1st division produces 2ndary oocyte and polar body

Difference between Meiosis and Mitosis



Meiosis I


One pair of homologous chromosomes (homologues)
Homologues Condense and cross over
Homologues Align
Homologues Separate
Meiosis I result: homologues separated into 2 cells
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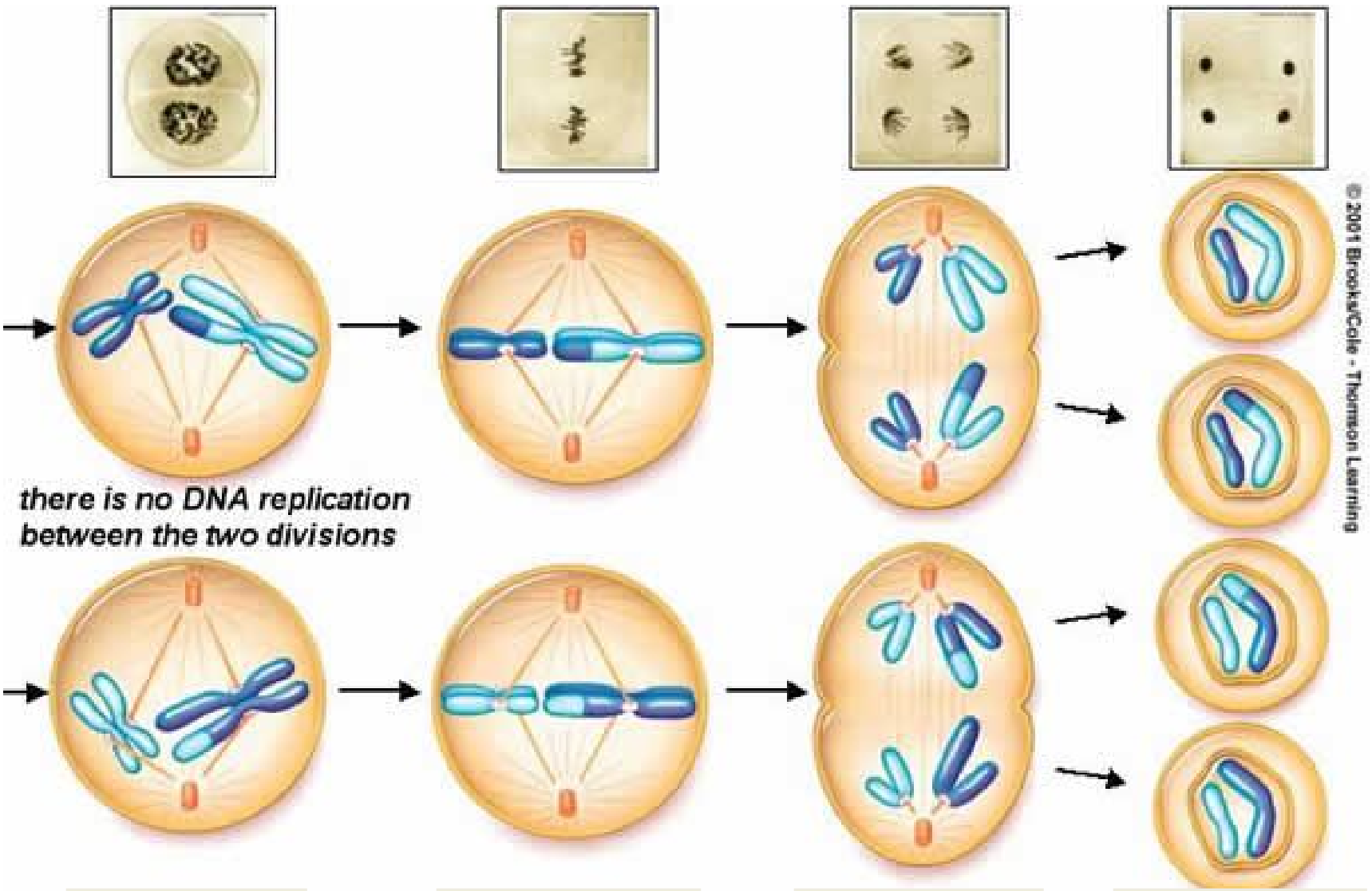
Interphase
Prophase I
Metaphase I
Anaphase I
Telephase I
MEIOSIS I: Separate the Homologues
Slide 5

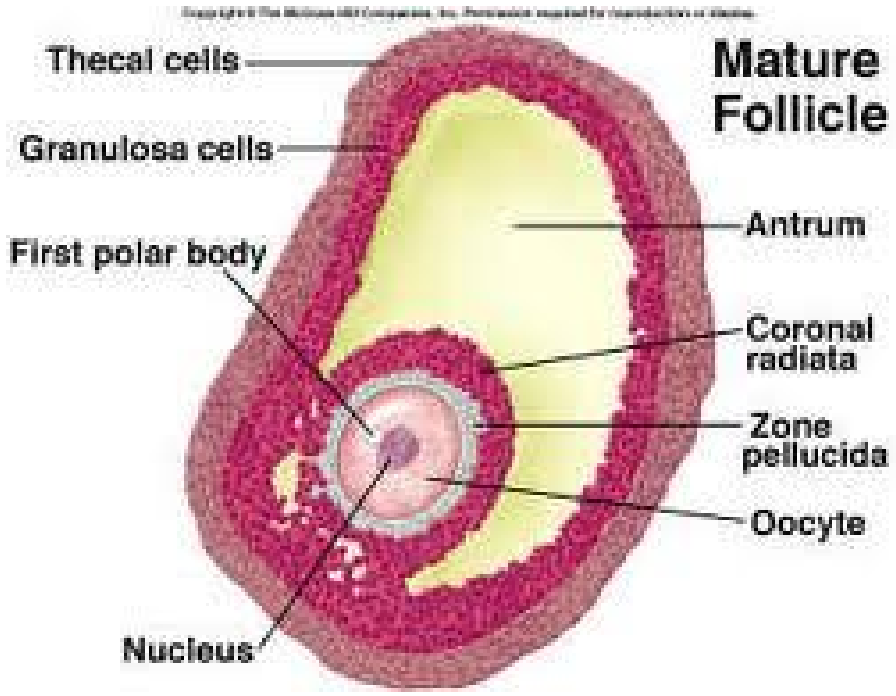
Meiosis II



MEIOSIS II: Separate the Sister Chromatids (by mitosis)

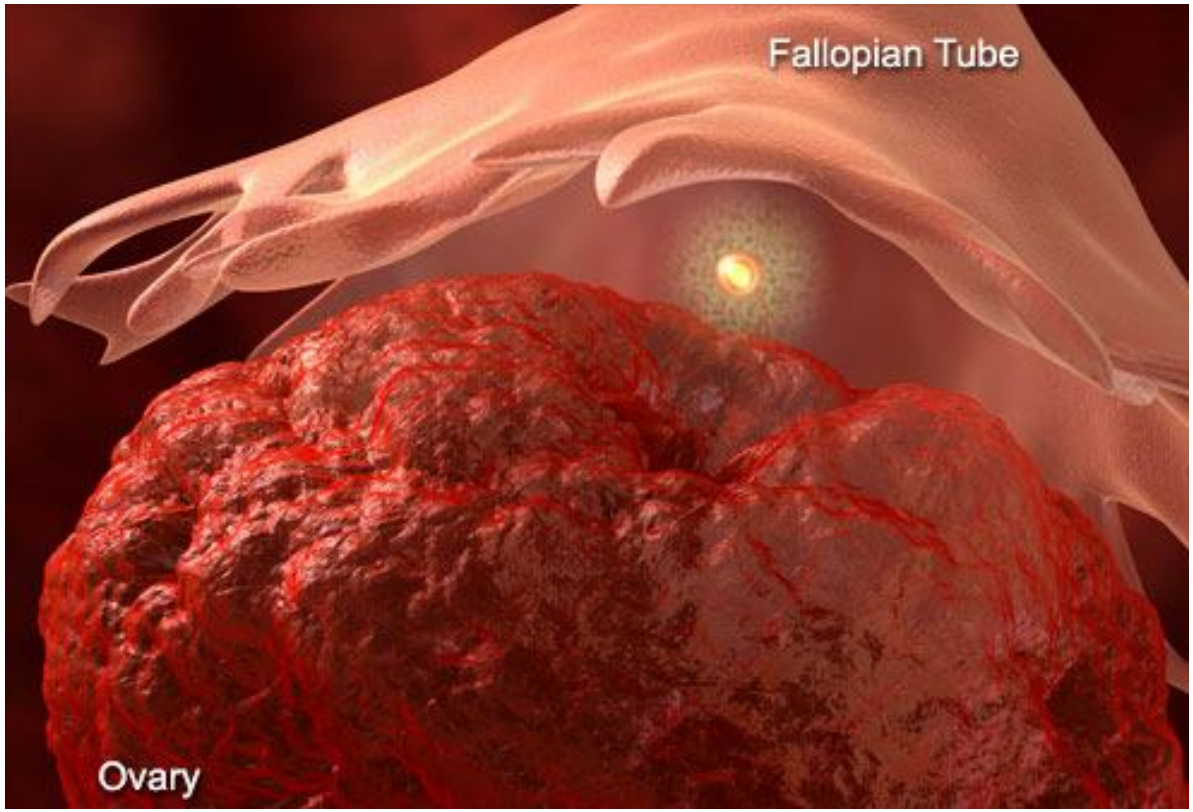
Oogenesis

- Aprox 1/2 way through the 28 day cycle the follicle reaches the mature Vesticular or Graffian follicle stage.



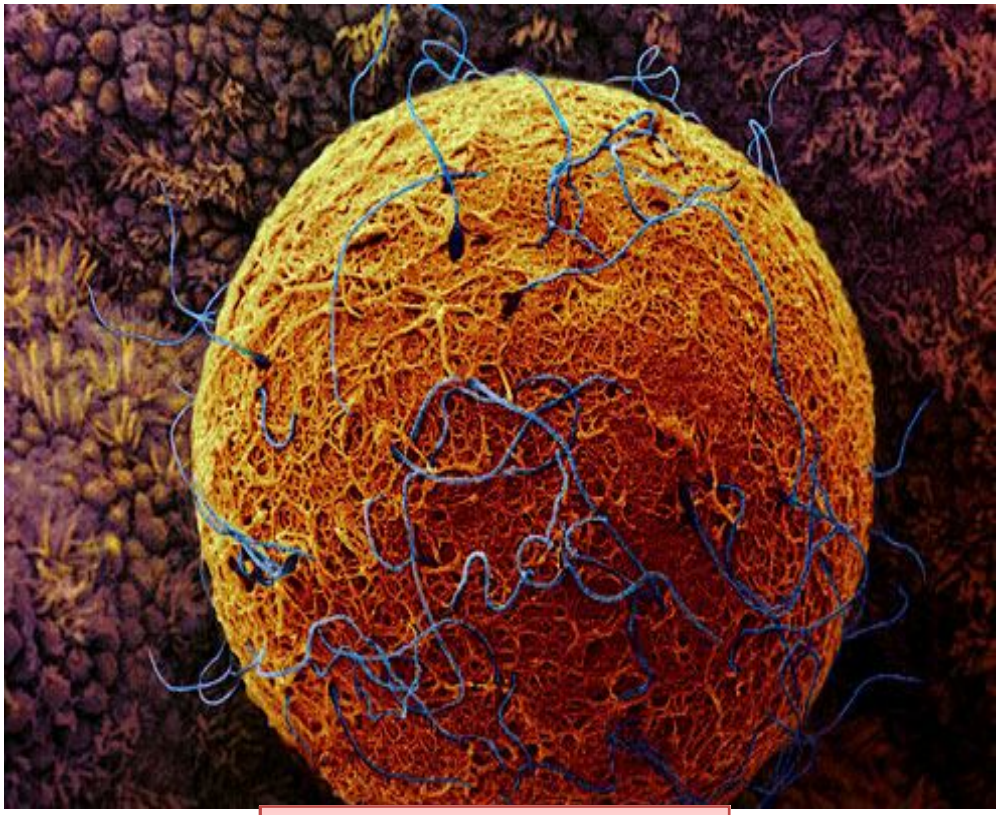
Oogenesis

- Estrogen levels rise and release LH and FSH and triggers ovulation.



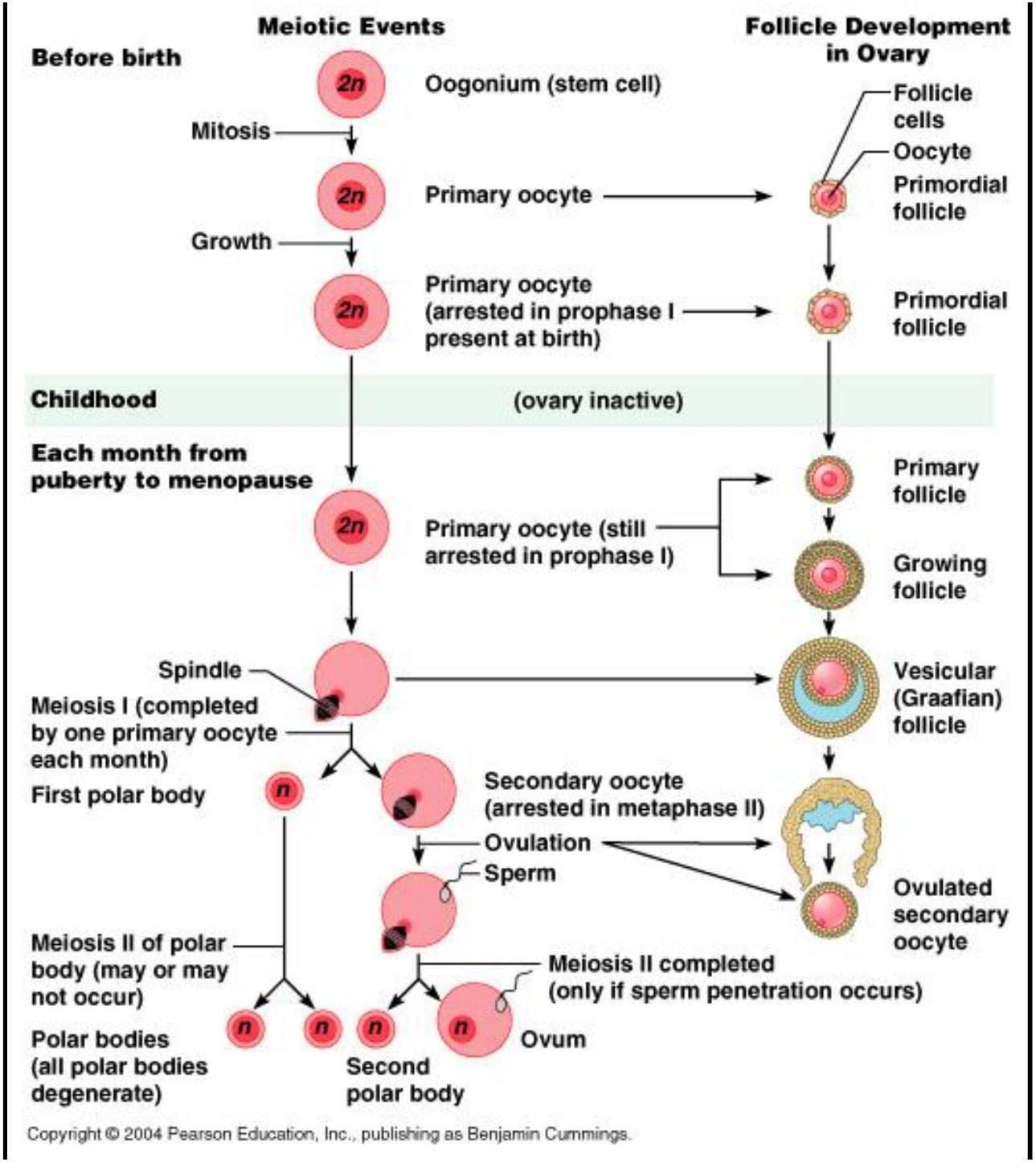
Oogenesis

- The 2ndary oocyte travels down the uterine tube to the uterus.
- If fertilized by sperm, it will produce a zygote



Ovum in uterine tube

Oogenesis


Meiotic Events
Follicle Development in Ovary
Before birth
2n
Oogonium (stem cell)
Follicle cells
Oocyte
Mitosis
2n
Primary oocyte
Primordial follicle
Growth
2n
Primary oocyte (arrested in prophase I present at birth)
Primordial follicle
Childhood
(ovary inactive)
Each month from puberty to menopause
Primary follicle
2n
Primary oocyte (still arrested in prophase I)
Growing follicle
Spindle
Vesicular (Graafian) follicle
Meiosis I (completed by one primary oocyte each month)
First polar body
n
Secondary oocyte (arrested in metaphase II)
Ovulation
Sperm
Ovulated secondary oocyte
Meiosis II of polar body (may or may not occur)
Meiosis II completed (only if sperm penetration occurs)
n
n
n
n
Ovum
Polar bodies (all polar bodies degenerate)
Second polar body
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Hormones of the Female Reproductive Cycle

- Control the reproductive cycle
- Coordinate the ovarian and uterine cycles
- Key hormones include:
  - FSH
    - Stimulates follicular development
  - LH
    - Maintains structure and secretory function of corpus luteum
  - Estrogens
    - Have multiple functions
  - Progesterones
    - Stimulate endometrial growth and secretion

Hormones Involved in the Female Reproductive Cycle

- Gonadotropin Releasing Hormone (GnRH)
- Follicle Stimulating Hormone (FSH)
- Luteinizing Hormone (LH)
- Estrogen
- Progesterone
- Inhibin
- Relaxin

GnRH

- Gonadotropin Releasing Hormone is secreted from the pituitary and through the portal system stimulates FSH release

FSH

- FSH exerts its primary effects on the follicles in the ovary.
- The follicular cells are stimulated to secrete estrogen

Estrogen

Primary female secondary sex hormone

Stimulates proliferation of the endometrial lining,(proliferative phase).

Stimulates the production of watery cervical mucus.

Luteinizing Hormone (LH)

LH secretion surges do to high levels of estrogen

LH surge leads to the oocyte to complete meiosis and causes ovulation.

LH transforms the follicle into the corpus luteum.

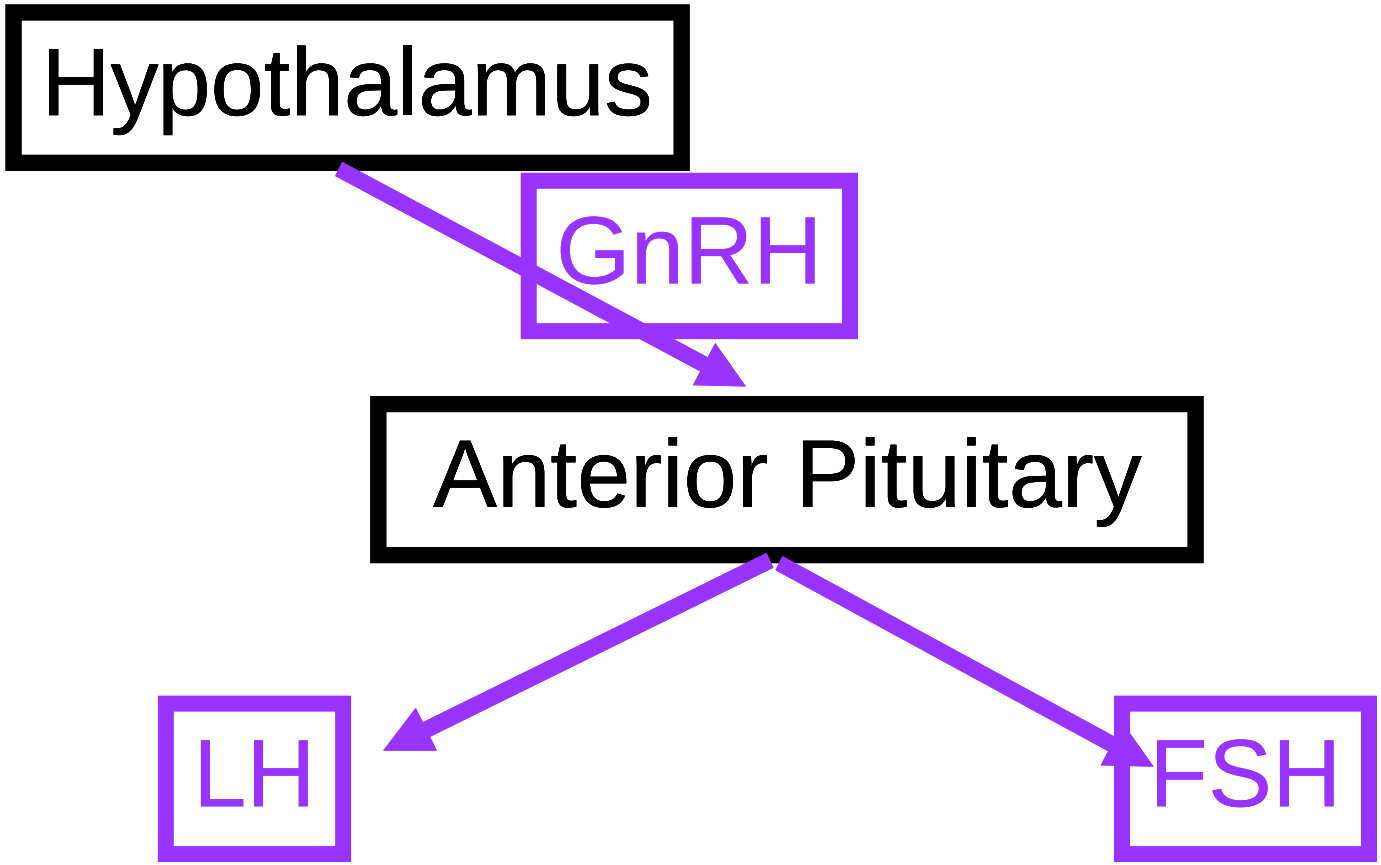
Progesterone

Secreted from the corpus luteum

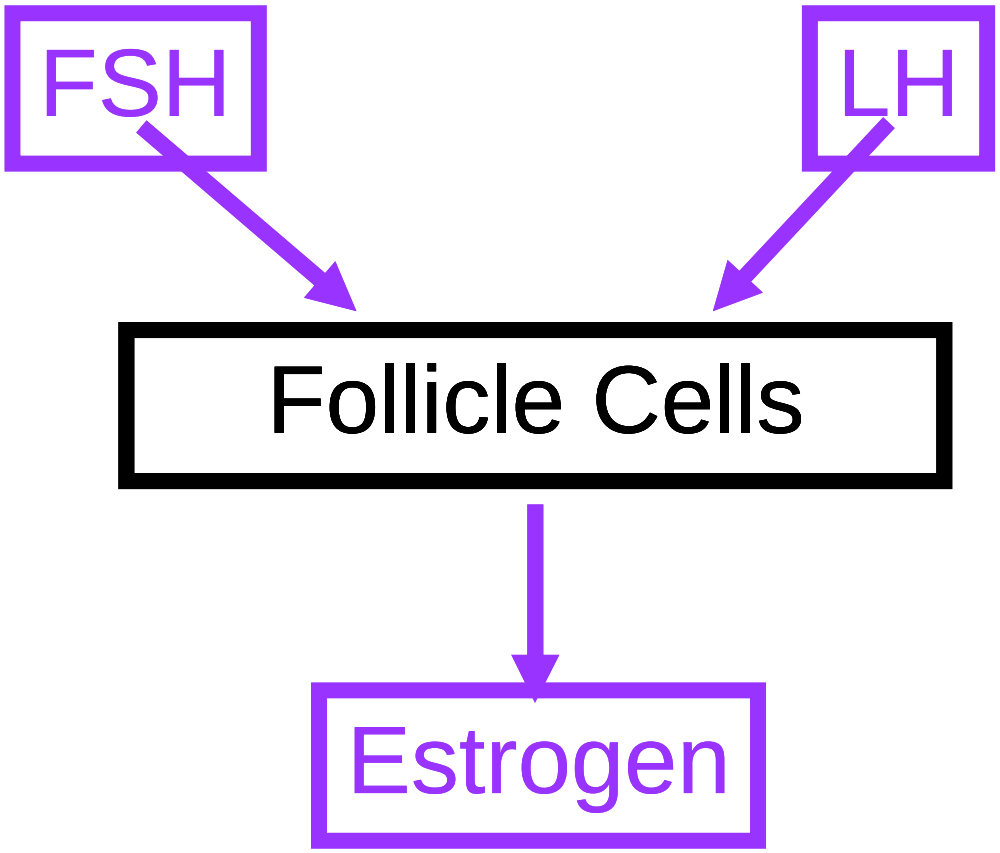
Along with estrogen, stimulates breast development

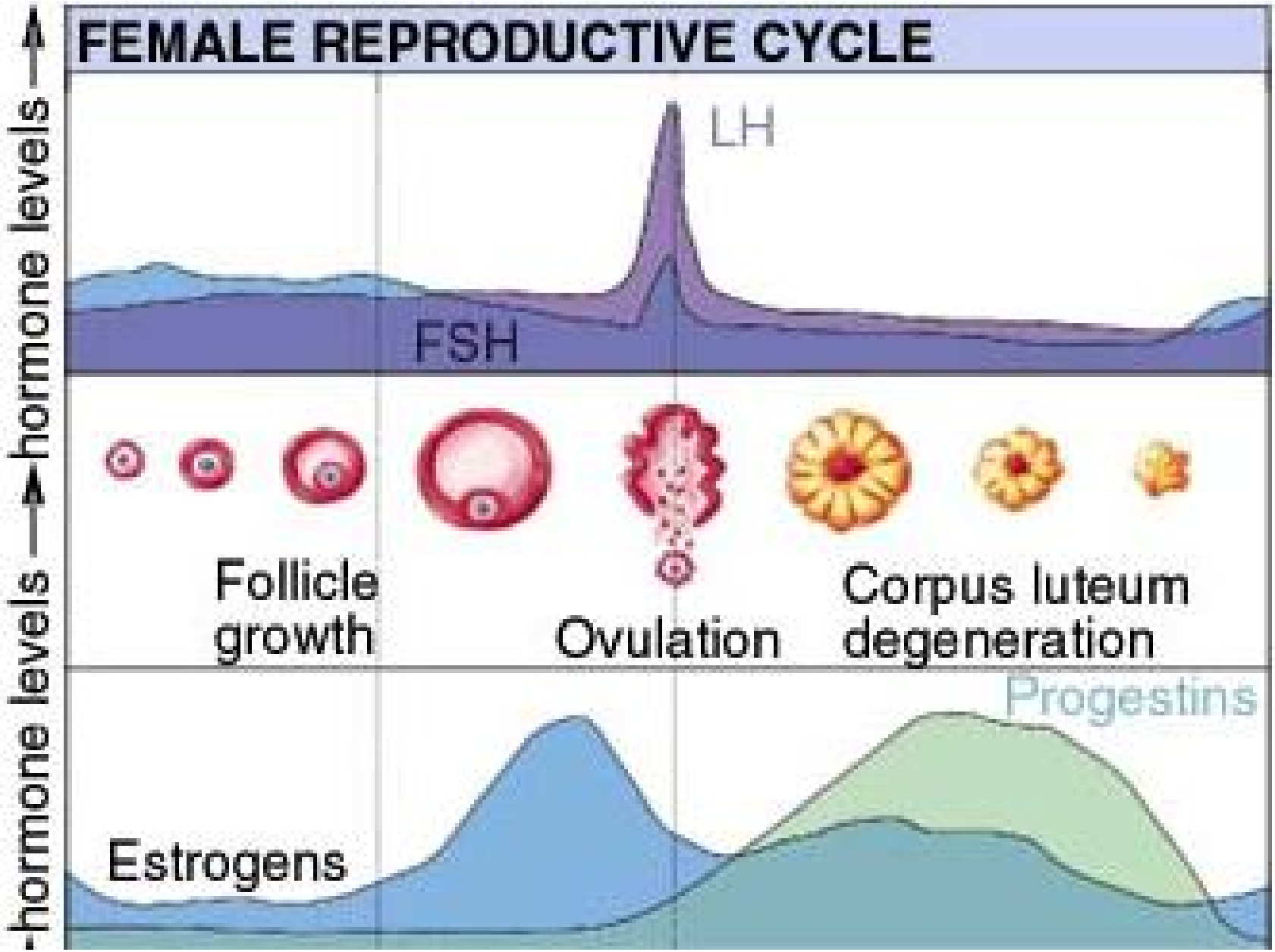
#Promotes the secretory phase of the uterine cycle.

Female Hormonal Cycle

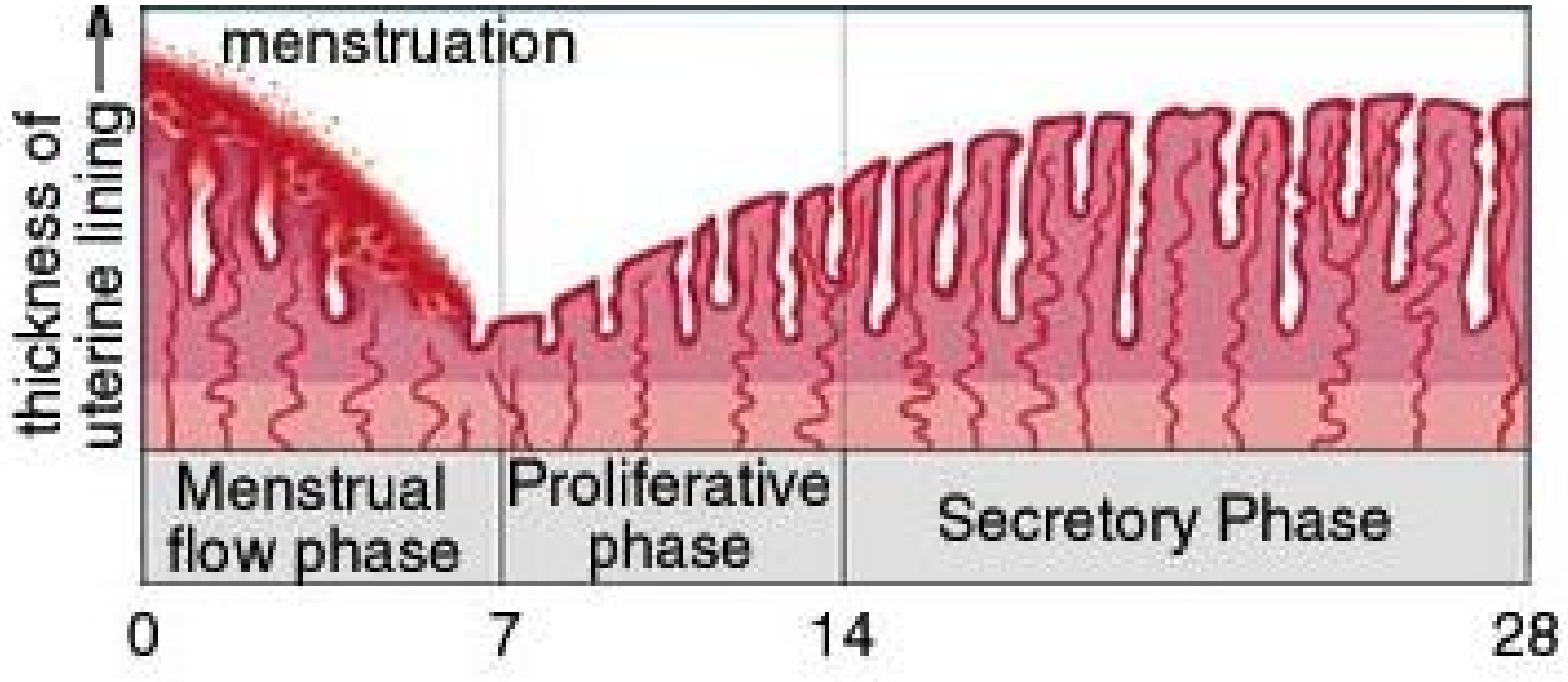


Female Hormonal Cycle

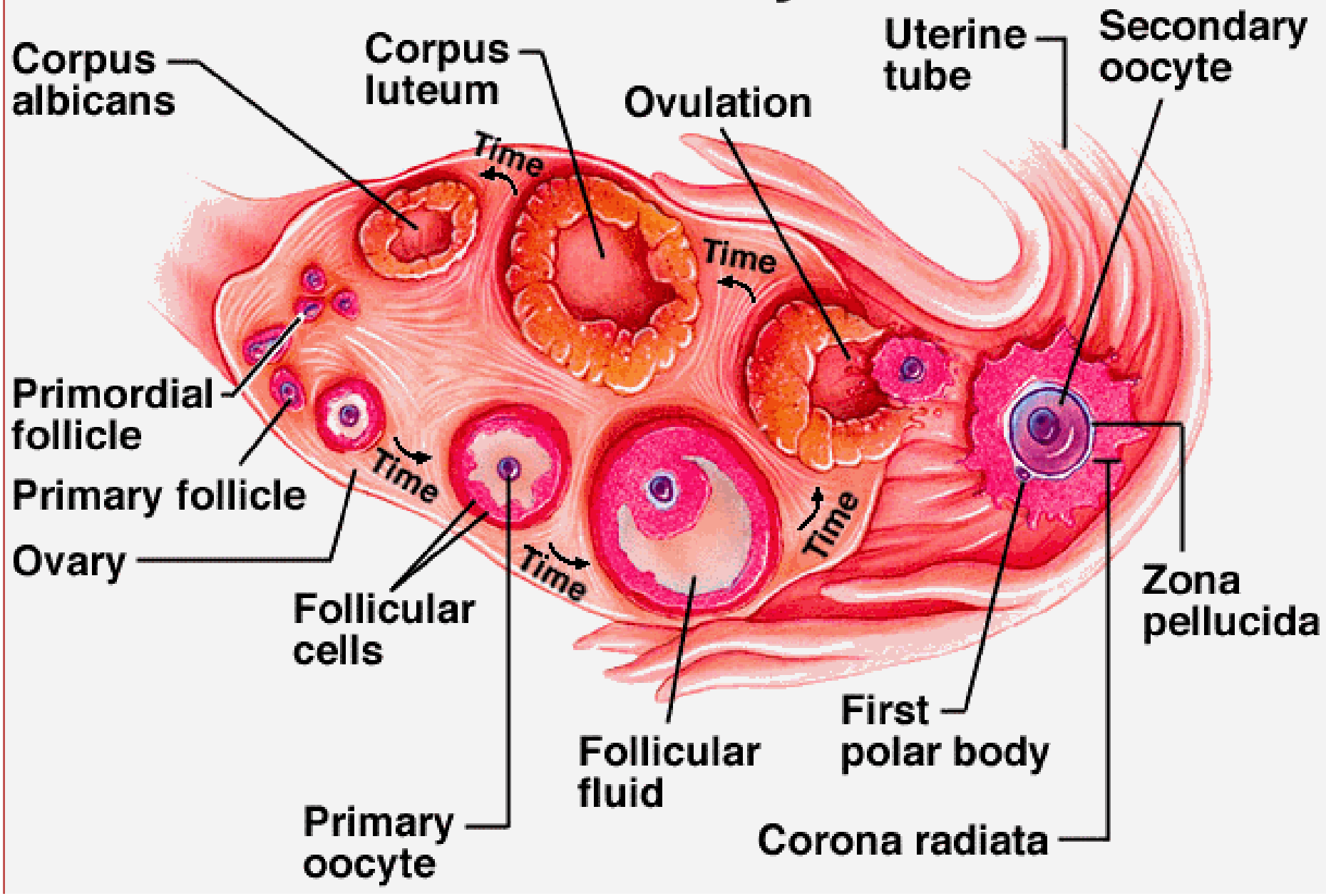


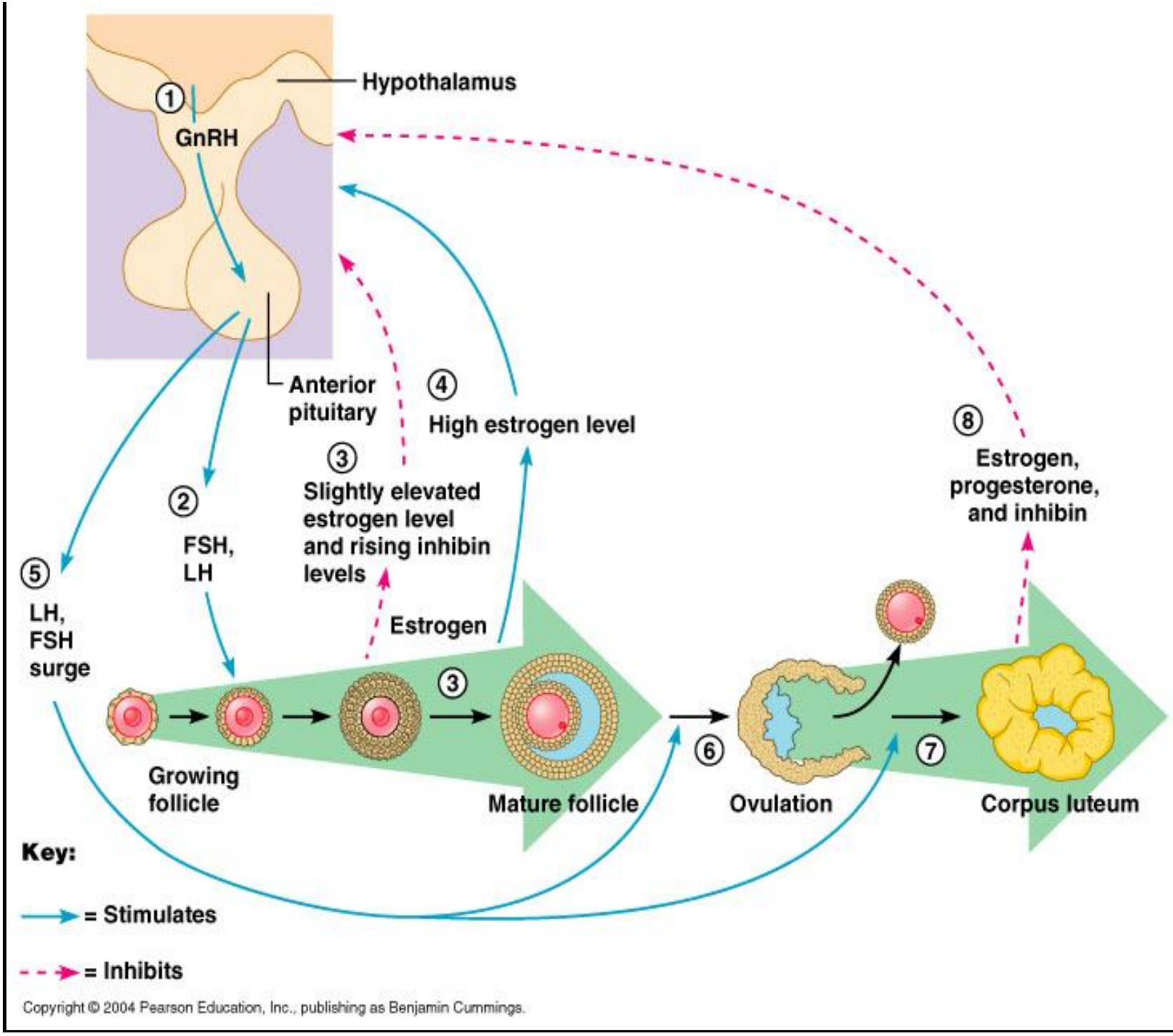

FEMALE REPRODUCTIVE CYCLE
hormone levels
LH
FSH
Follicle growth
Ovulation
Corpus luteum degeneration
Progestins
Estrogens

The Uterine Cycle

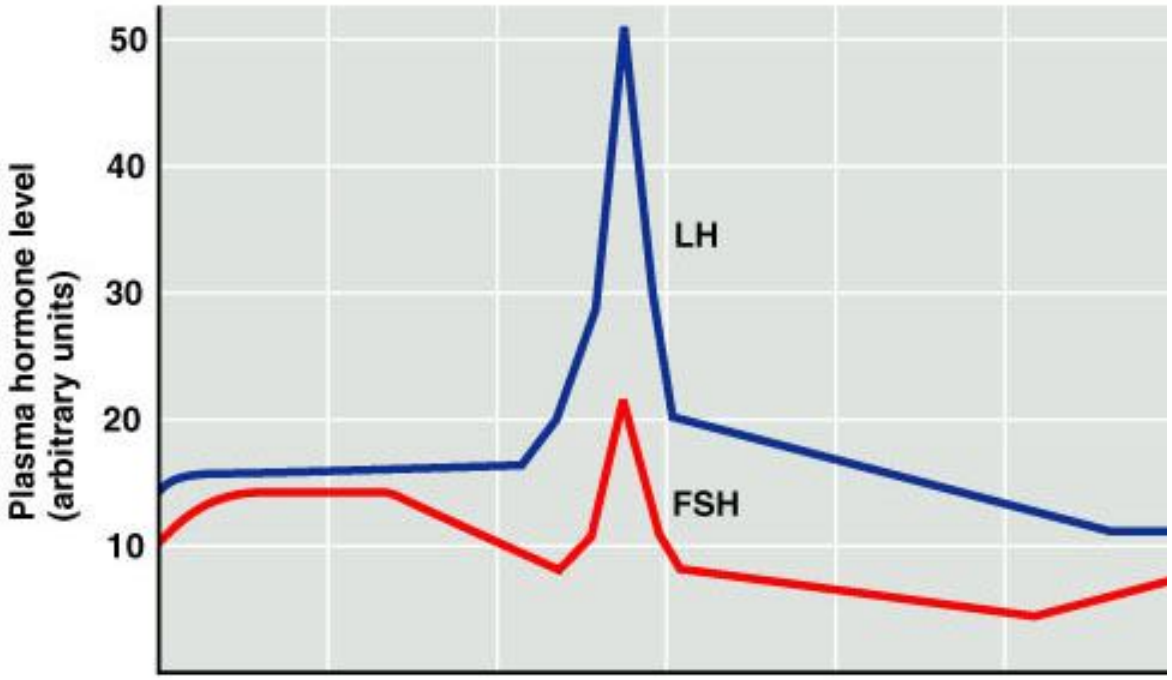


Ovarian Cycle

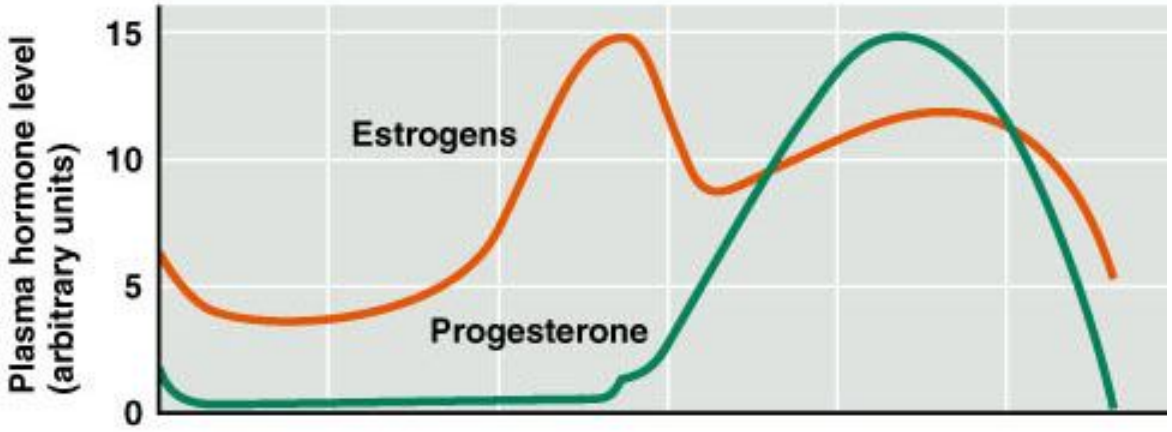




Hormone Fluctuation



(a) Fluctuation of gonadotropin levels



(b) Fluctuation of ovarian hormone levels

Some Other Effects of Estrogen

- breast development
- external genitalia growth
- bone growth
- fat deposition
- Increase protein anabolism
- Decrease blood cholesterol
- Facilitate calcium uptake
- Promotes hydration of skin
- Feminizes brain

Menopause: cessation of ovarian and menstrual cycles.

- Usually occurs between ages 46 and 54.
- Due to ovaries decreased responsiveness to gonadotropins.

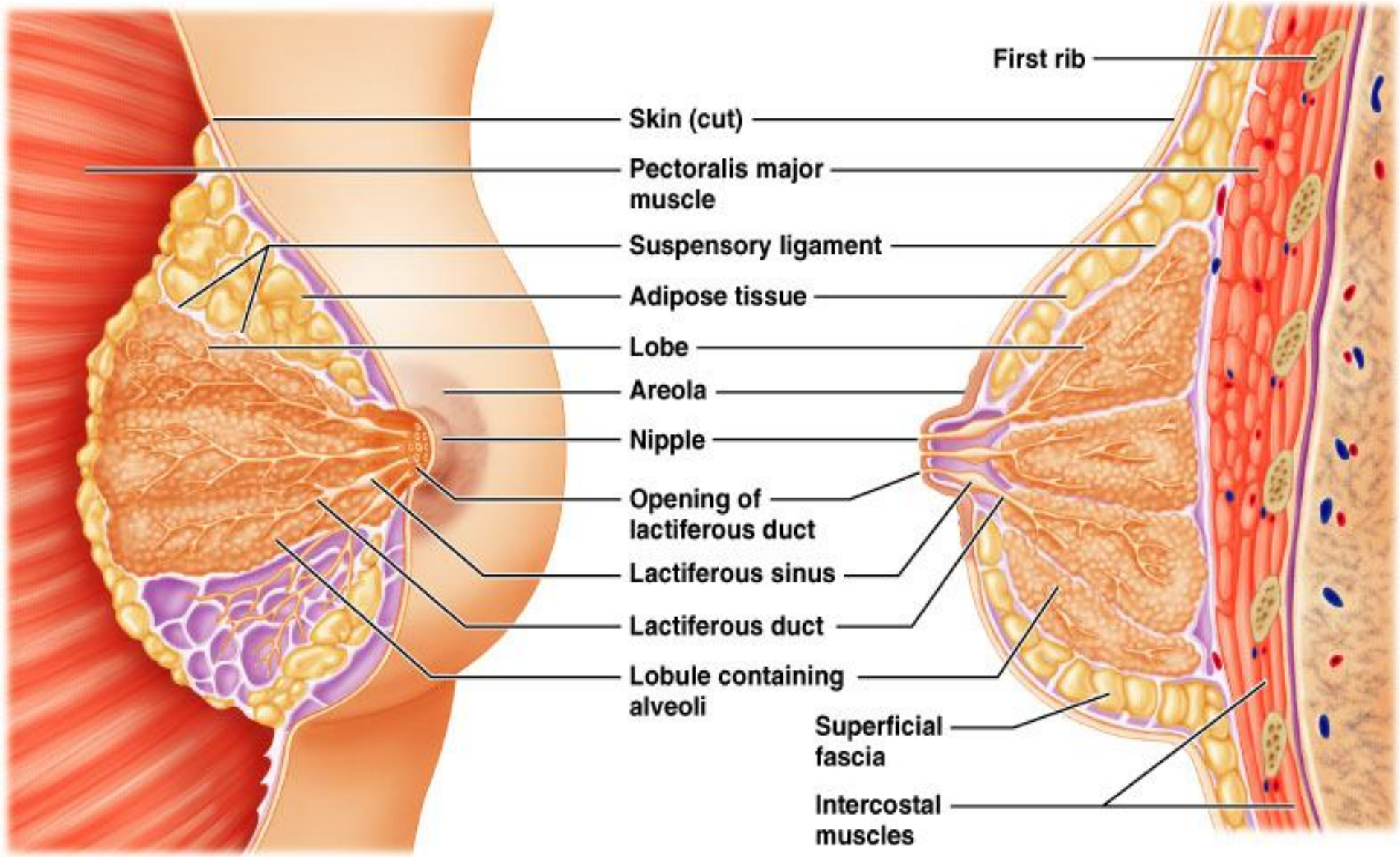
Menopause affects:

- changes in sexual desire
- triggers mood swings
- causes debilitating hot flashes
- may lead to bone and heart problems
- short-term memory loss
- insomnia

Mammary glands

- Are present in both males and females.
- Are not a component of the reproductive system.
- Contain epithelial tissue that secrete milk.
  - Milk drains into a series of ducts opening at the nipple.

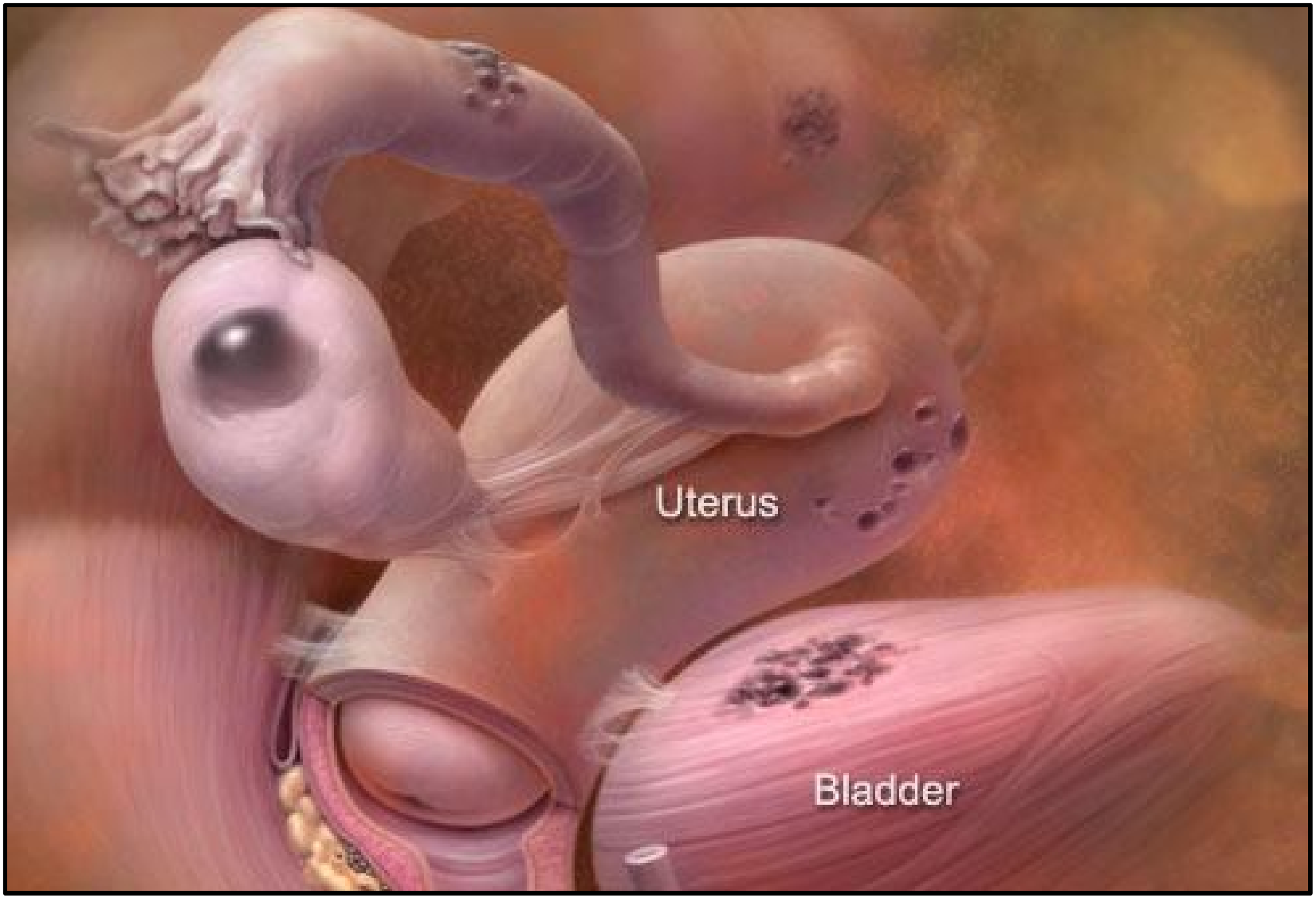
Mammary Gland

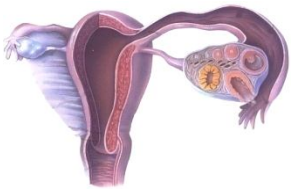


Ectopic Pregnancy

Ovarian Cyst

Endometriosis





FEMALE REPRODUCTIVE SYSTEM

The Ovarian Cycle

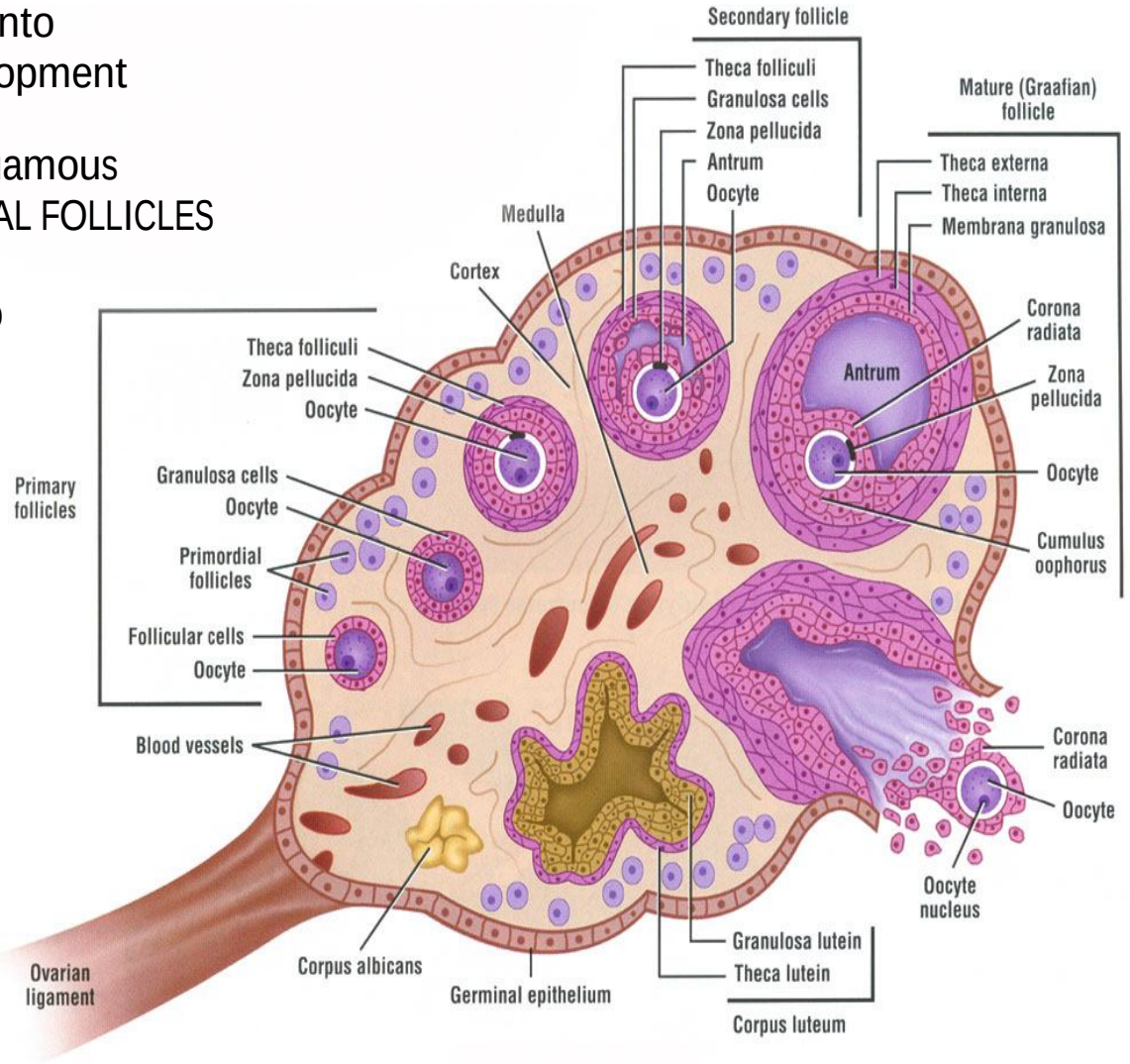
- OVARY

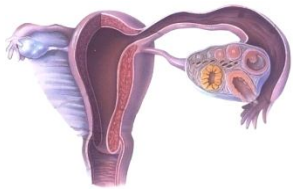
3 to 5 million OOGONIA differentiate into PRIMARY OOCYTES during early development

OOCYTES becomes surrounded by squamous (follicular) cells to become PRIMORDIAL FOLLICLES

most PRIMORDIAL FOLLICLES undergo *atresia* leaving 400,000 at birth

oocytes at birth arrested at Meiosis I (prophase)





FEMALE REPRODUCTIVE SYSTEM

- OVARY

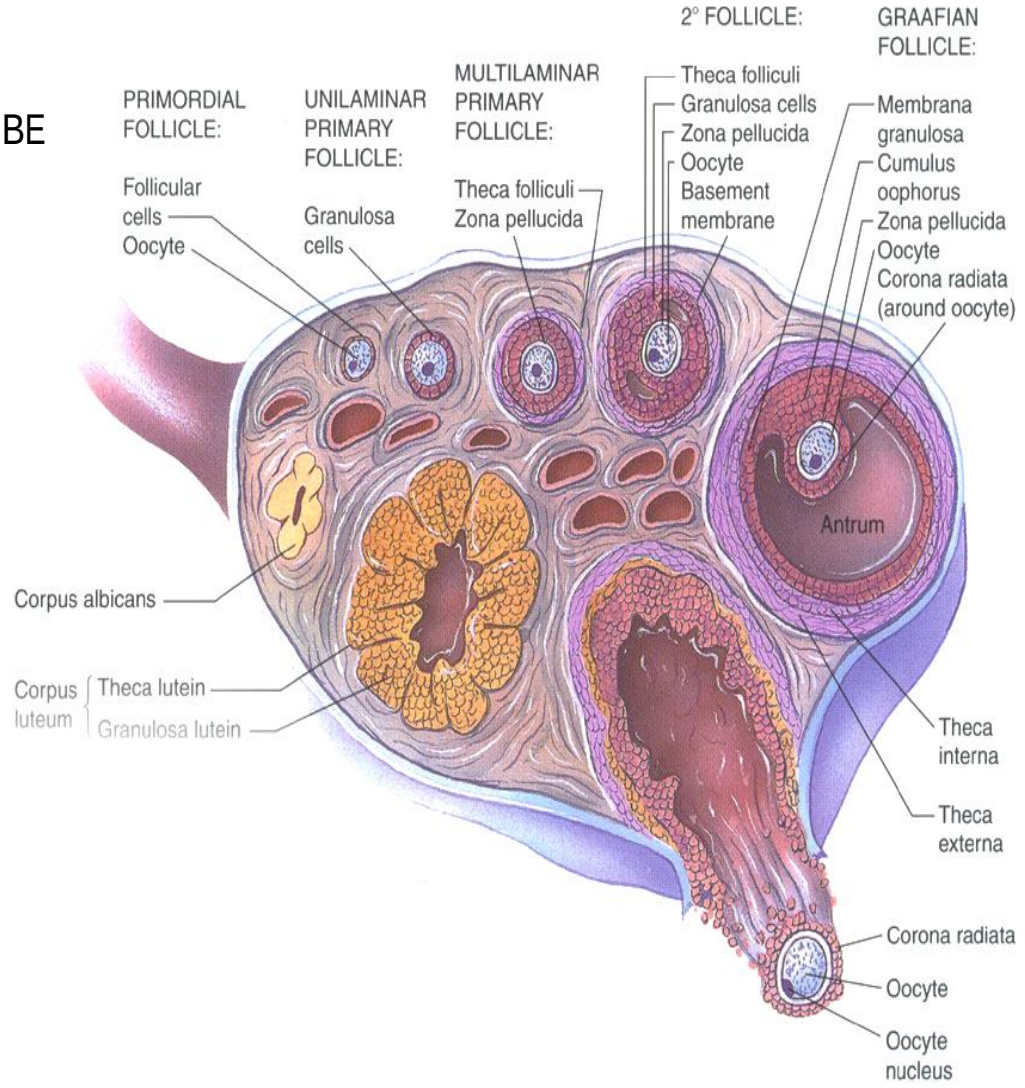
THREE STAGES OF OVARIAN FOLLICLES CAN BE IDENTIFIED FOLLOWING PUBERTY:
(each follicle contains one oocyte)

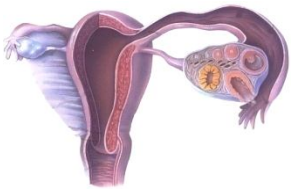
OOGENESIS

(1) PRIMORDIAL FOLLICLES
- very prevalent; located in the periphery of the cortex
- a single layer of squamous follicular cells surround the oocyte

(2) GROWING FOLLICLES
- three recognizable stages:
  (a) early primary follicle
  (b) late primary follicle
  (c) secondary (antral) follicle

(3) MATURE (GRAAFIAN) FOLLICLES
- follicle reaches maximum size





FEMALE REPRODUCTIVE SYSTEM

- OVARIAN FOLLICLES

(1) PRIMORDIAL FOLLICLES

(2) GROWING FOLLICLES

(a) early primary follicle

- follicular cells still *unilaminar* but now are cuboidal in appearance
- oocyte begins to enlarge

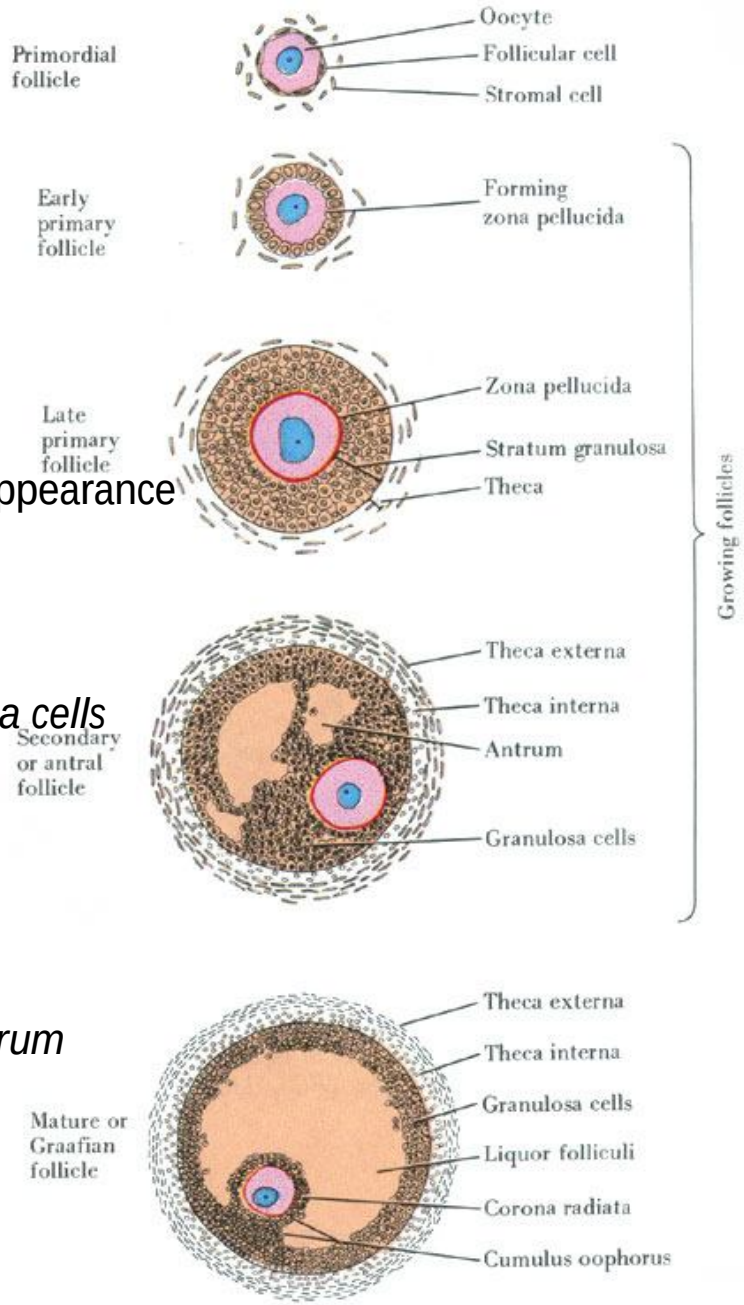
(b) late primary follicle

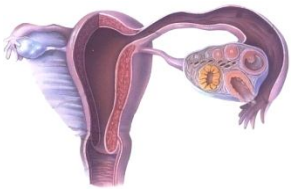
- *multilaminar* follicular layer; cells now termed *granulosa cells*
- *zona pellucida* appears; gel-like substance rich in GAGs
- surrounding *stromal cells* differentiate into *theca interna* and *theca externa*

(b) secondary (antral) follicle

- cavities appear between granulosa cells forming an *antrum*
- follicle continues to grow
- formation of *cumulus oophorus* and *corona radiata*

(3) MATURE (GRAAFIAN) FOLLICLES

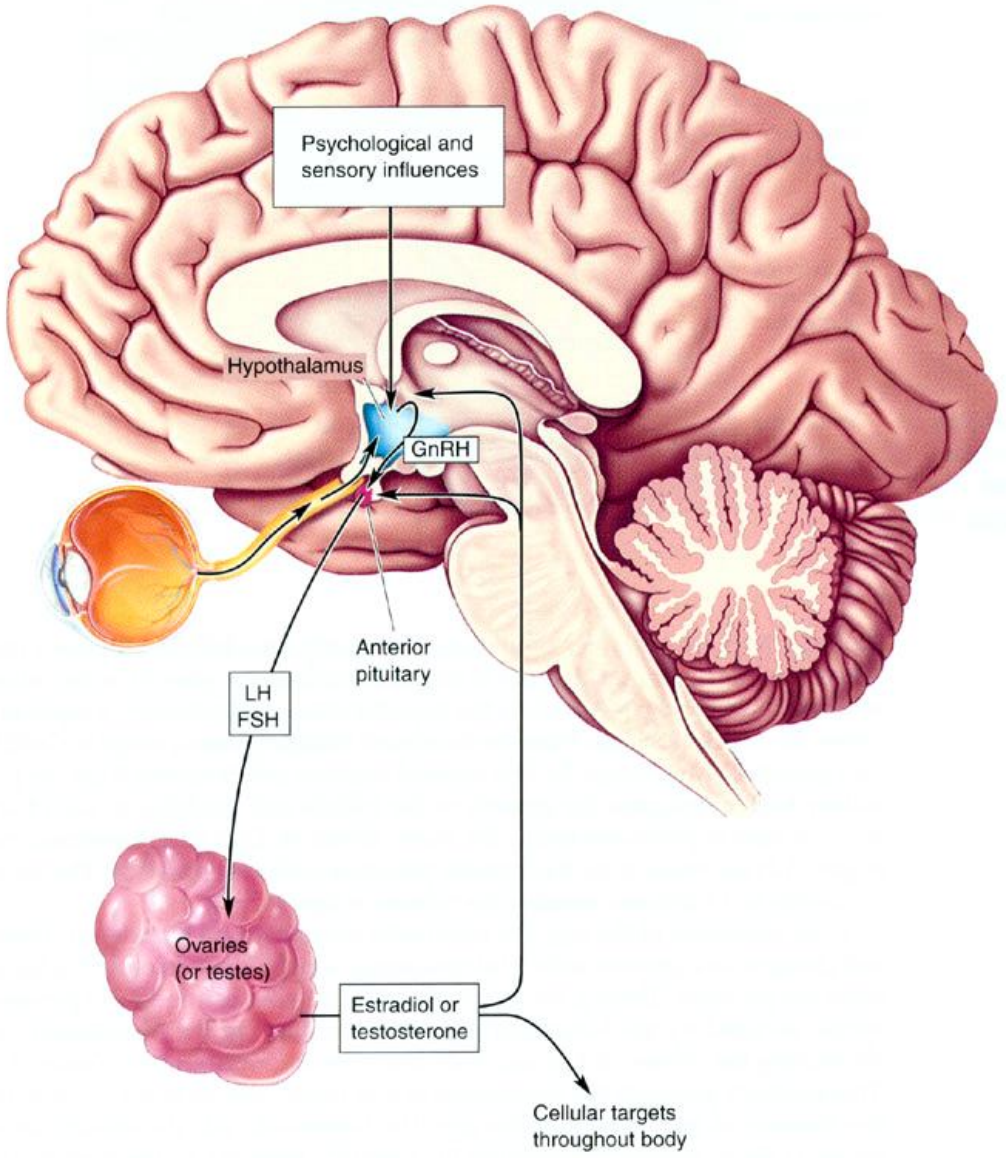


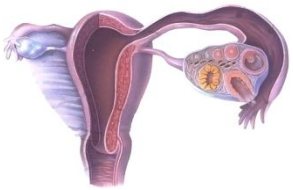


FEMALE REPRODUCTIVE SYSTEM

- HORMONAL REGULATION OF OOGENSIS AND OVULATION

HYPOTHALAMUS release of GnRF which stimulates release of LH and FSH from the adenohypophysis (ANTERIOR PITUITARY)





FEMALE REPRODUCTIVE SYSTEM The Menstrual Cycle

- HORMONAL REGULATION OF OOGENSIS AND OVULATION

OVULATION

FOLLICULAR PHASE

10-20 primordial follicles begin to develop in response to FSH and LH levels

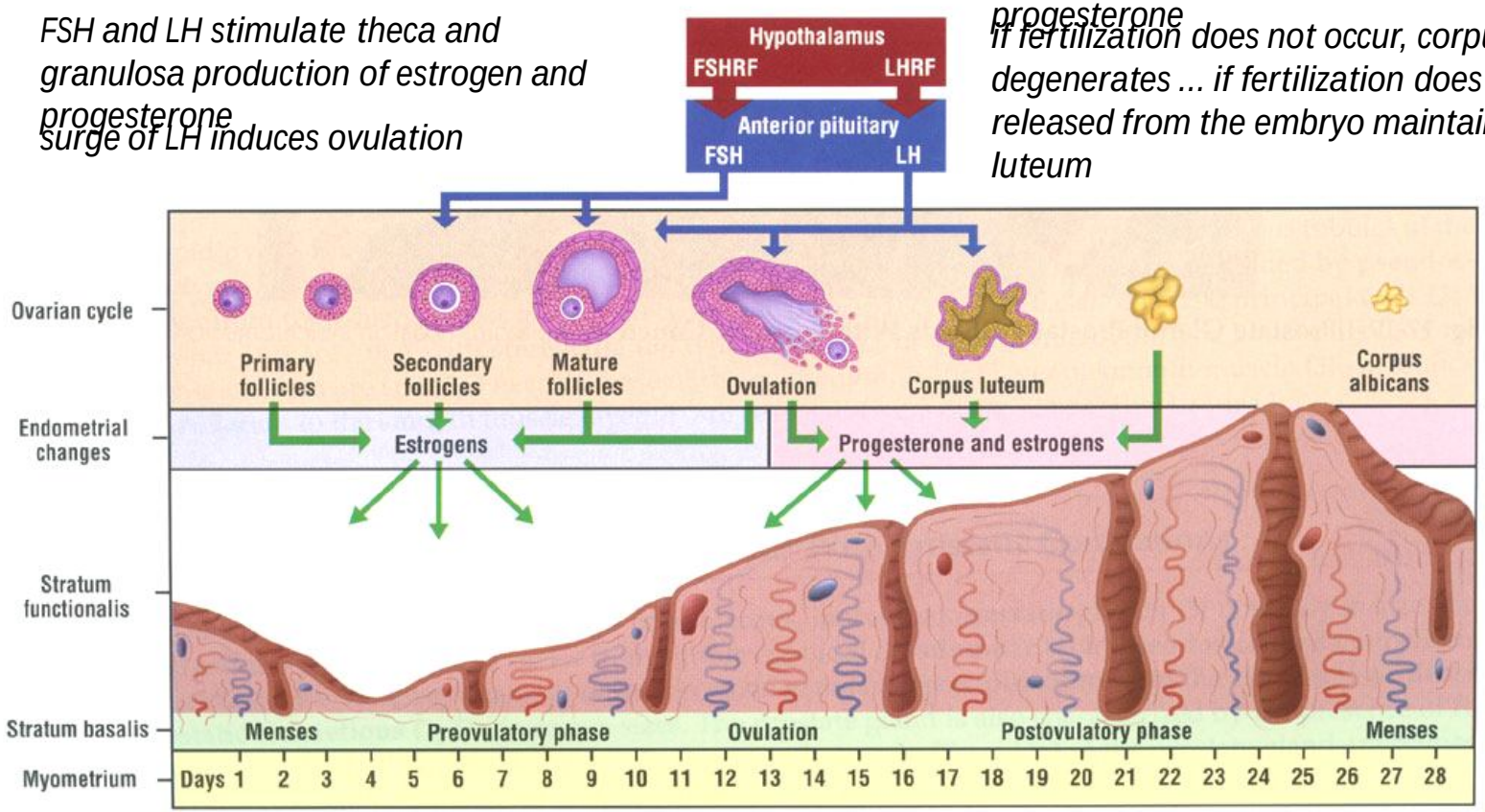
FSH and LH stimulate theca and granulosa production of estrogen and progesterone

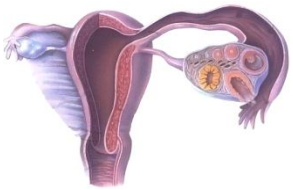
surge of LH induces ovulation

LUTEAL PHASE

theca and granulosa cells transform into the corpus luteum and secrete large amounts of progesterone

if fertilization does not occur, corpus luteum degenerates ... if fertilization does occur, HCG released from the embryo maintains corpus luteum





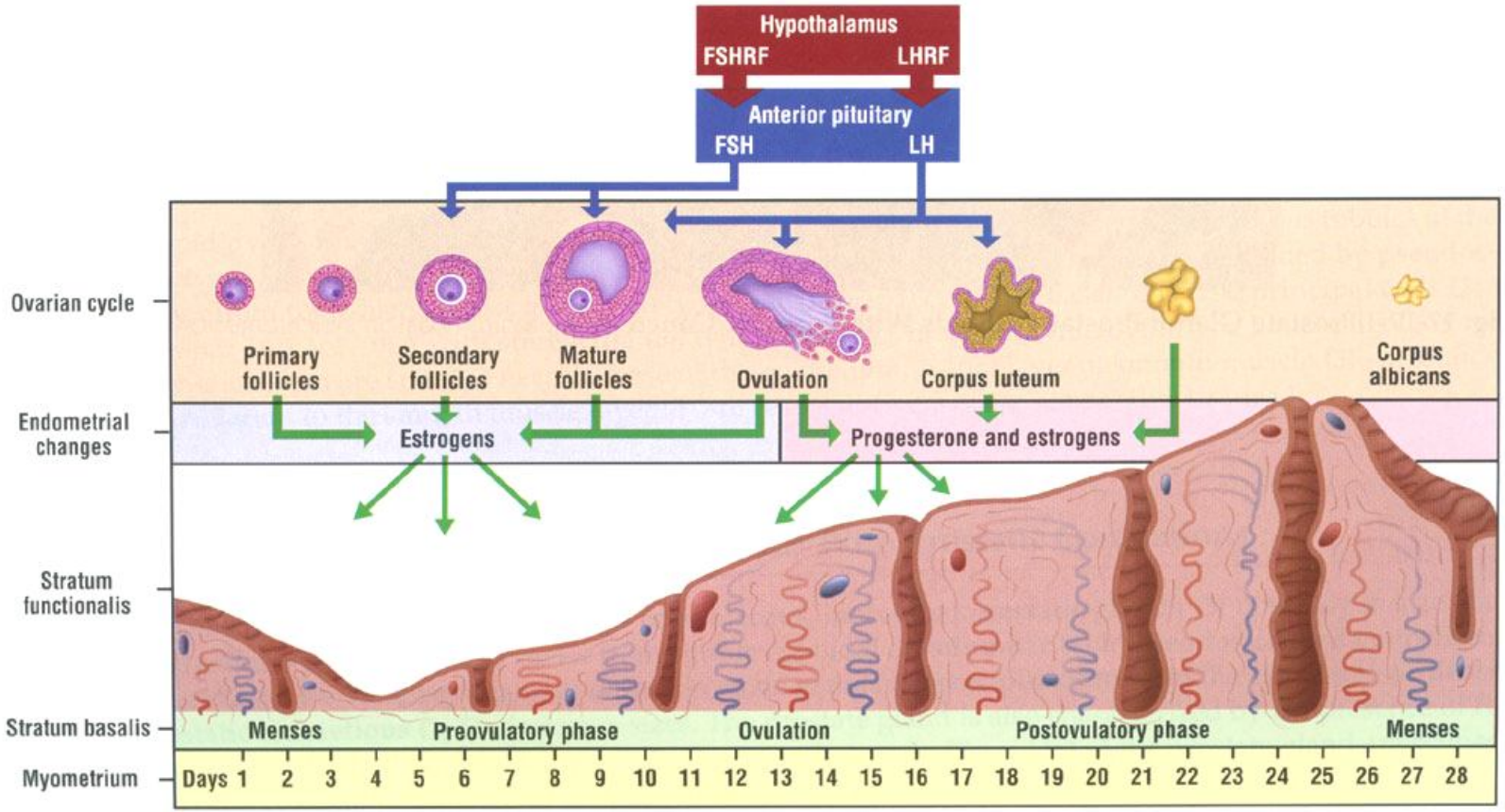
FEMALE REPRODUCTIVE SYSTEM

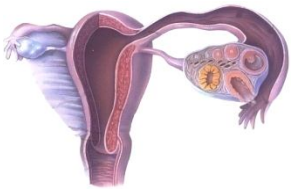
- HORMONAL REGULATION OF UTERINE CYCLE

(1) PROLIFERATIVE PHASE — *concurrent with follicular maturation and influenced by estrogens*

(2) SECRETORY PHASE — *concurrent with luteal phase and influenced by progesterone*

(3) MENSTRUAL PHASE — *commences as hormone production by corpus luteum declines*





FEMALE REPRODUCTIVE SYSTEM The Menstrual Cycle

- HORMONAL REGULATION OF OOGENSIS AND OVULATION

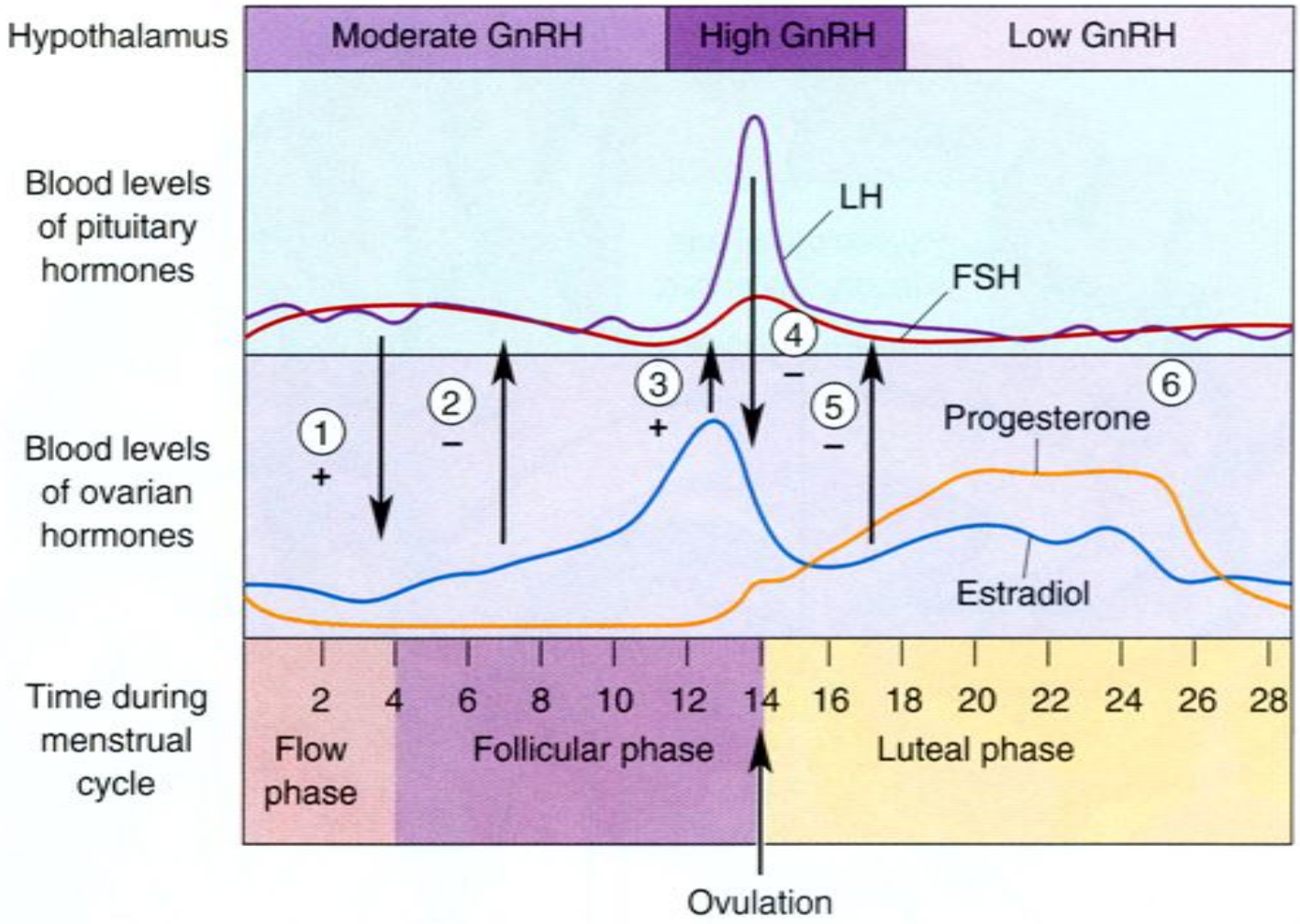
OVULATION:

sharp surge in LH with simulataneous increase in FSH

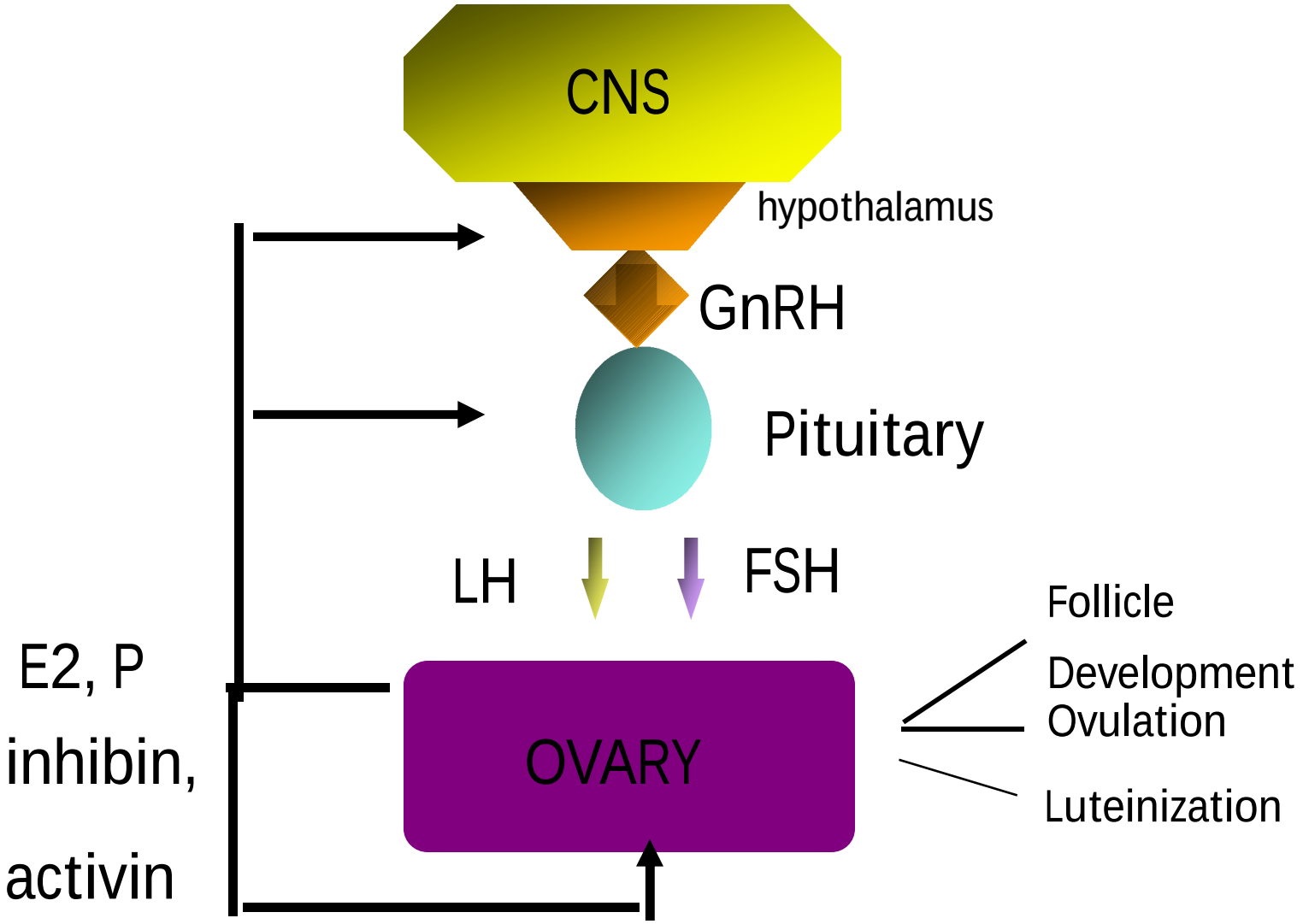
Meiosis I resumes; oocyte and surrounding cumulus break away and are extruded

oocyte passes into oviduct

ECTOPIC IMPLANTATIONS



Neuroendocrine Regulation of Ovarian Functions



Effects of GnRH on Gonadotropins

- GnRH is released in a pulsatile manner, stimulating the synthesis and release of LH and FSH.
- GnRH acts through its receptor on the pituitary gonadotroph cells, stimulating production of phospholipase C.
- Recall that IP3 pathway causes gonadotropin release, while the DAG/PKC pathway causes gonadotropin synthesis.

Regulation of Progesterone Production

- Progesterone is produced from theca cells, mature granulosa cells, and from the corpus luteum.
- In this case, gonadotropins induce expression of

  - steroidogenic acute regulatory protein

  - P450 side chain cleavage

Actions of Estradiol

- Estradiol also has important actions in a number of other tissues:
  - causes proliferation of uterine endometrium
  - increases contractility of uterine myometrium
  - stimulates development of mammary glands
  - stimulates follicle growth (granulosa cell proliferation)
  - effects on bone metabolism, hepatic lipoprotein production, genitourinary tract, mood, and cognition
- Effects are mediated through the intracellular estrogen receptors (alpha and beta), and possible membrane effects.

Actions of Progesterone

- Progesterone exerts positive and negative feedback effects on gonadotropin synthesis and release.
- Progesterone also acts on many tissues:

  - stimulates secretory activity of the uterine endometrium

  - inhibits contractility of the uterine myometrium

  - stimulates mammary growth
- The actions of progesterone are mediated through an intracellular P receptor, which acts as a transcription factor.