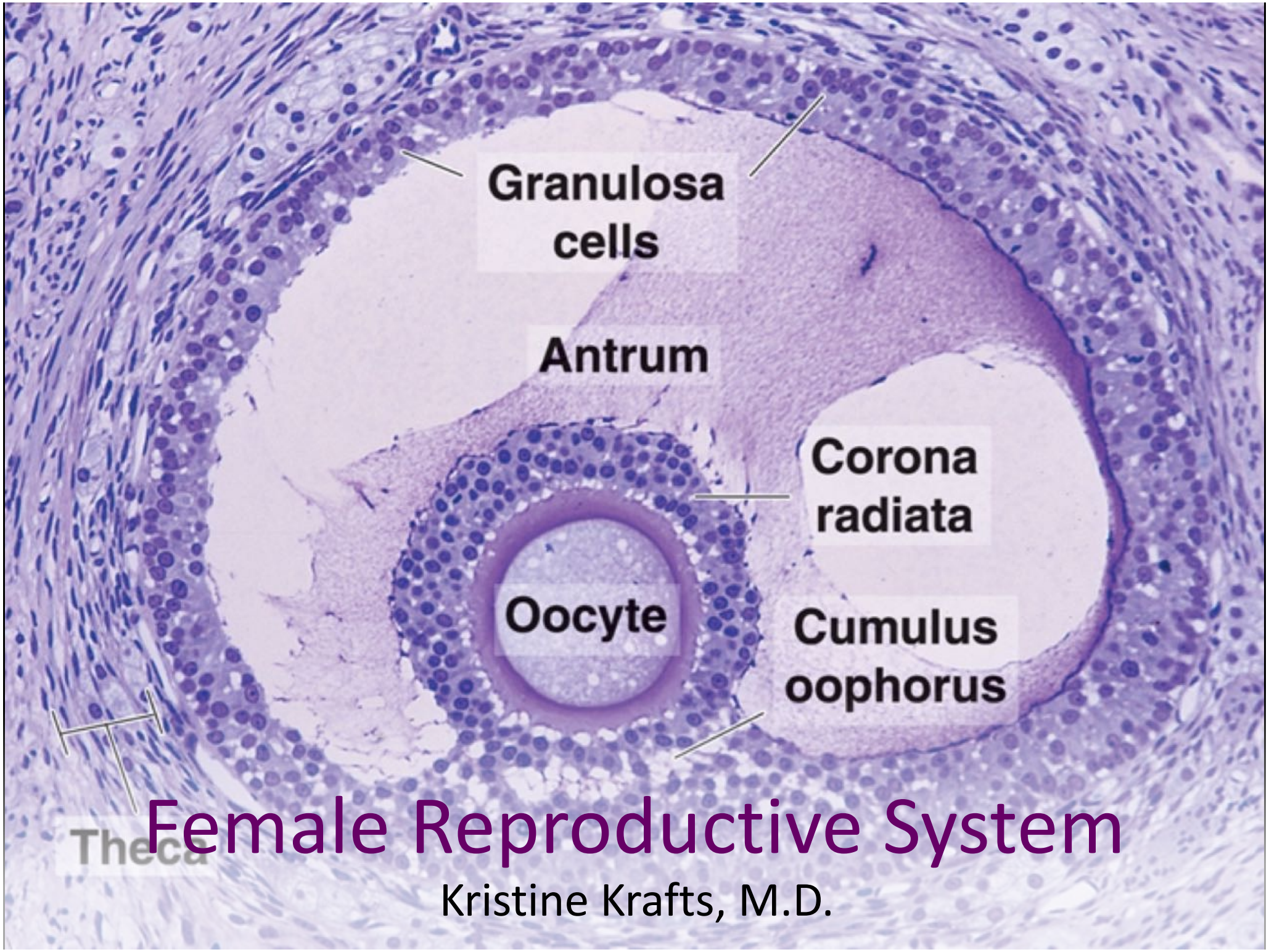


Female Reproductive System

Kristine Krafts, M.D.

Female Reproductive System Objectives

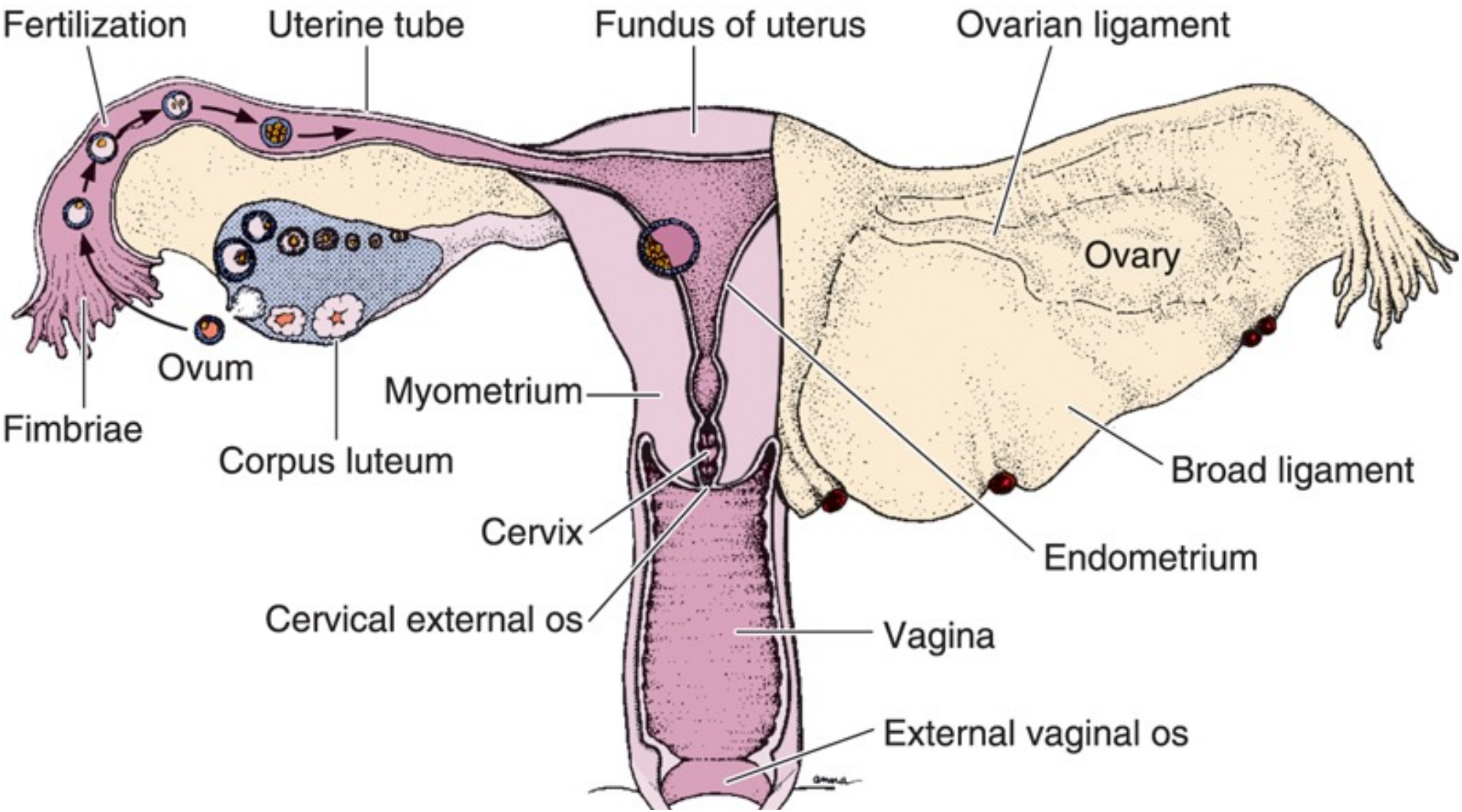
- Describe the microscopic characteristics of the uterus, cervix, and ovary.
- Describe the microscopic features of the stages of development of ovarian follicles. Describe the endocrine events associated with development of follicles.

Female Reproductive System Objectives

- Describe the development, structure and function of the corpus luteum.
- Describe the events and hormones in the phases of the menstrual cycle, and the associated microscopic features of the uterus and ovary.

Female Reproductive System Lecture Outline

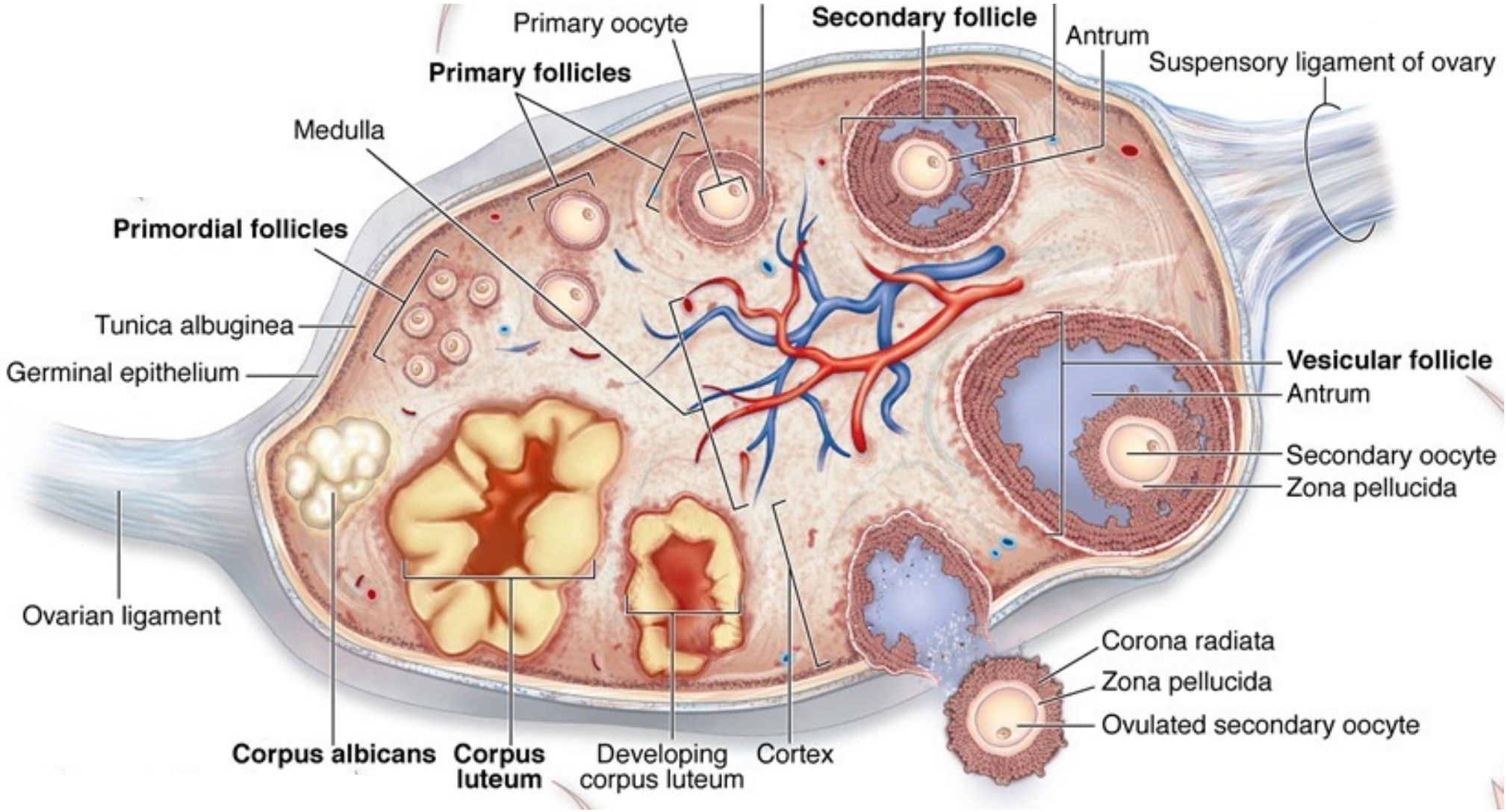
- Ovary
- Uterus
- Cervix



Female Reproductive System

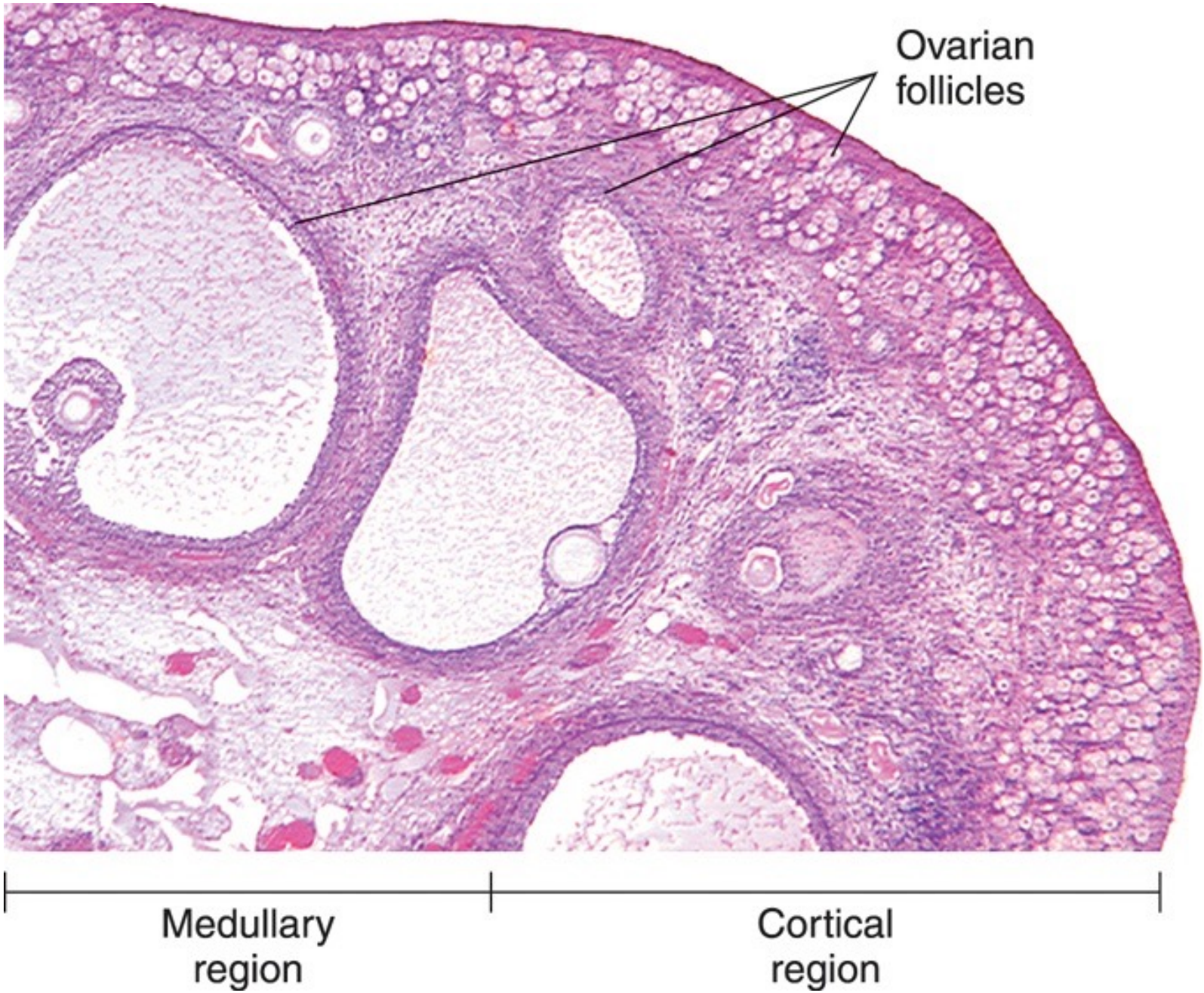
Female Reproductive System Lecture Outline

- Ovary

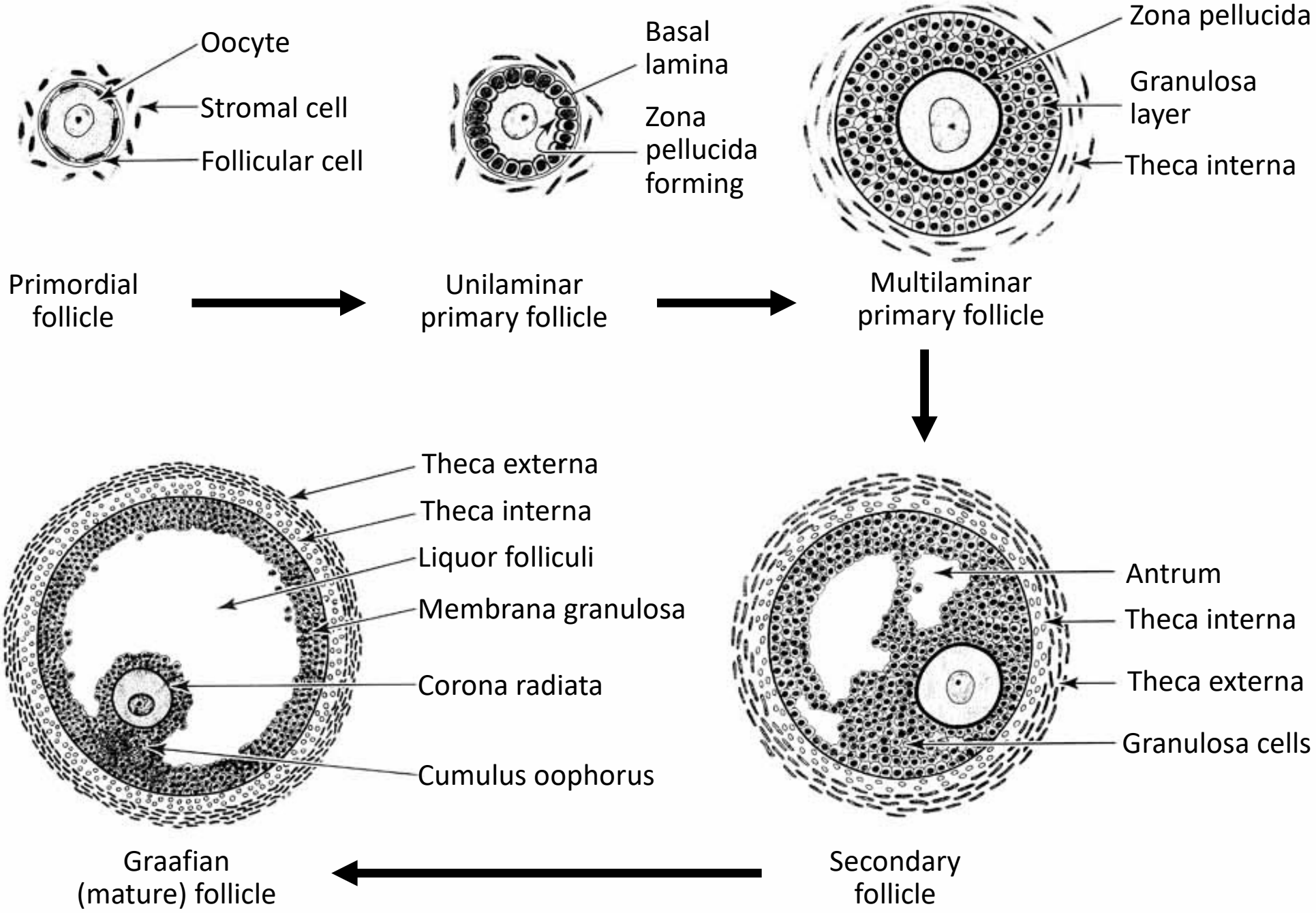


Cross section of ovary

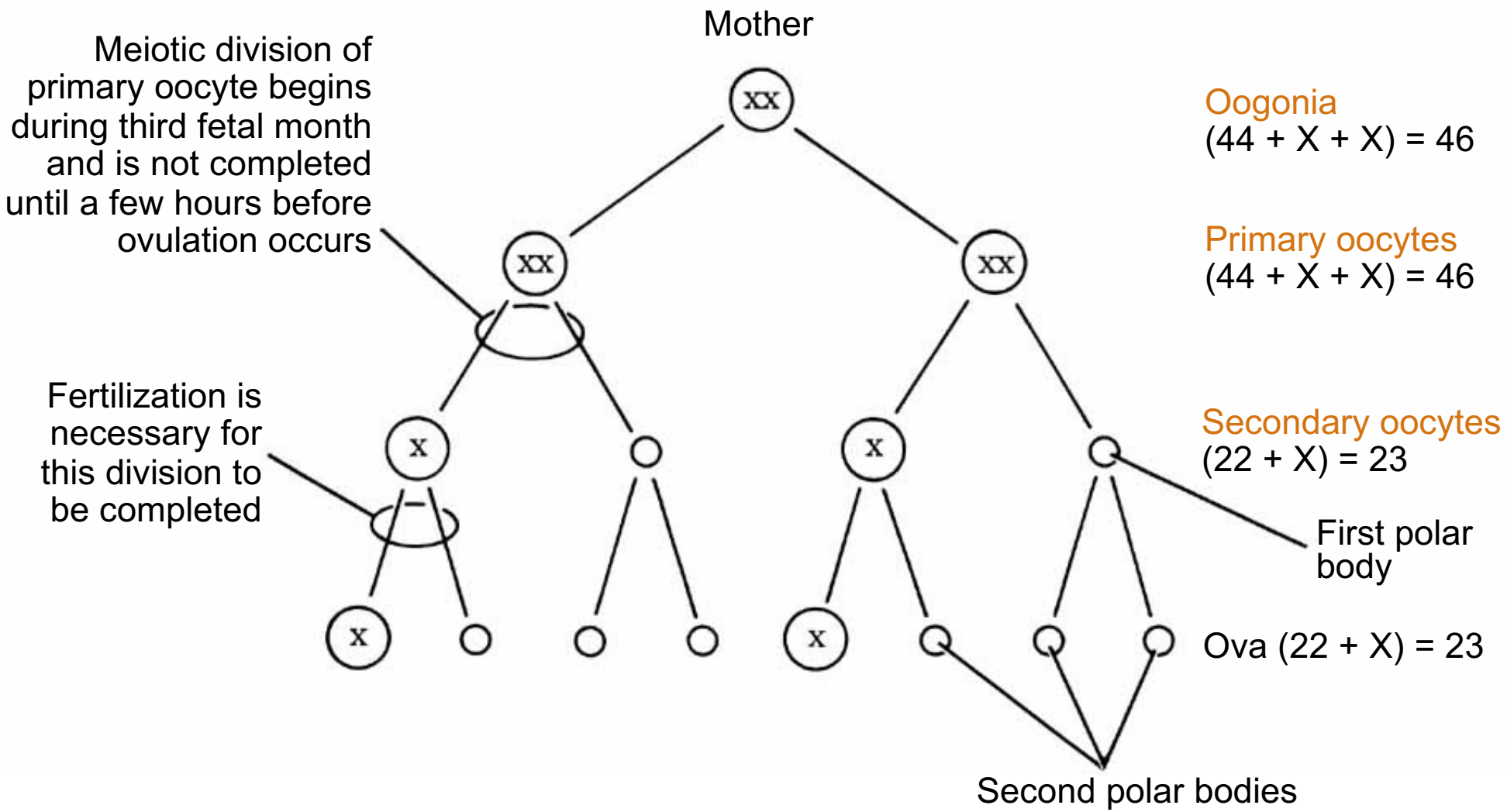
Cortex and medulla of ovary



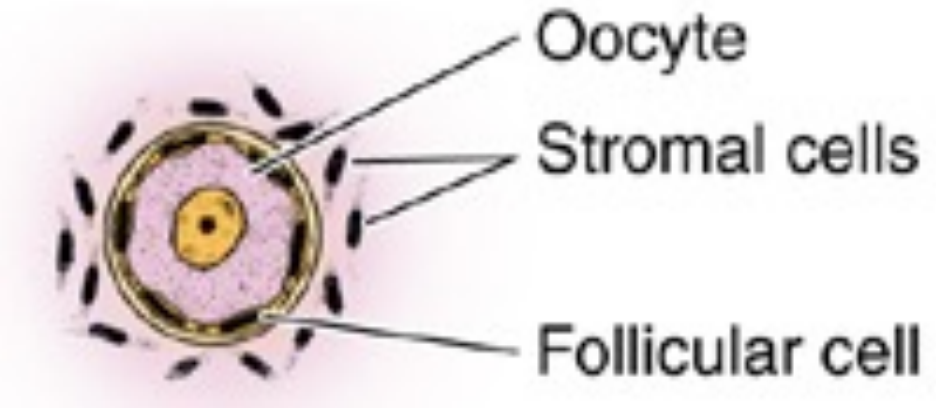
Follicle Development



Oocyte Development

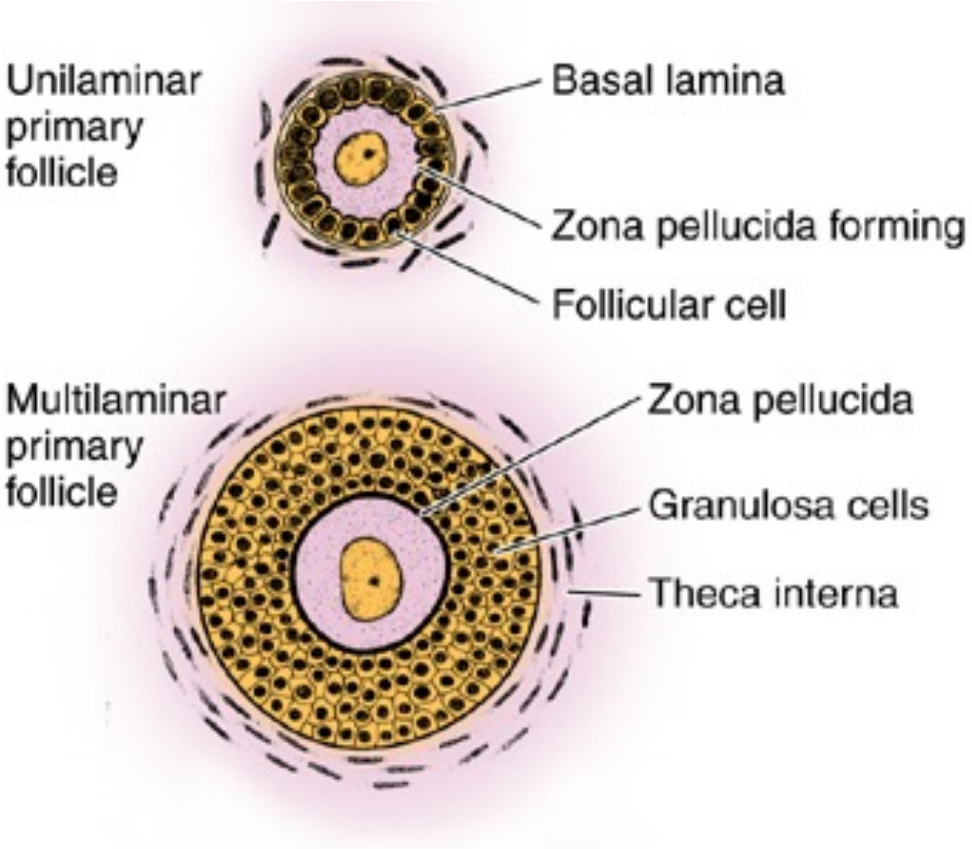


Primordial Follicle



- Develop during fetal life.
- Consist of a primary oocyte in prophase of 1st meiotic division surrounded by one layer of flattened follicular cells.
- Many primordial follicles degenerate at this stage in a process called atresia.

Primary Follicles



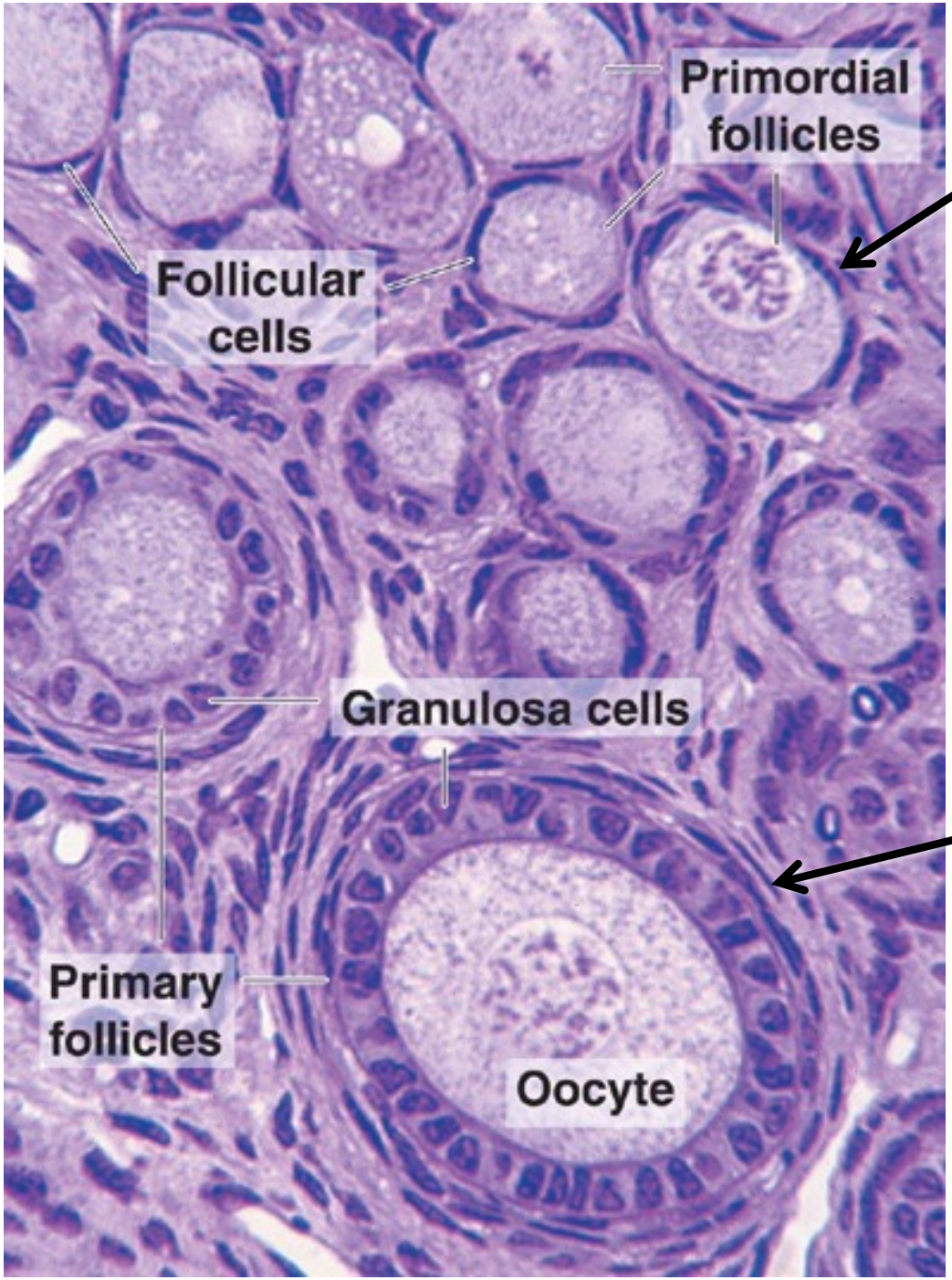
The zona pellucida is made of glycoproteins and forms between oocyte and granulosa cells.

At puberty, under influence of FSH, some primordial follicles mature.

Oocyte still in prophase of 1st meiosis (prophase 1).

Stromal fibroblasts proliferate and differentiate into theca cells.

Multiple layers of follicular cells develop and are called granulosa cells.

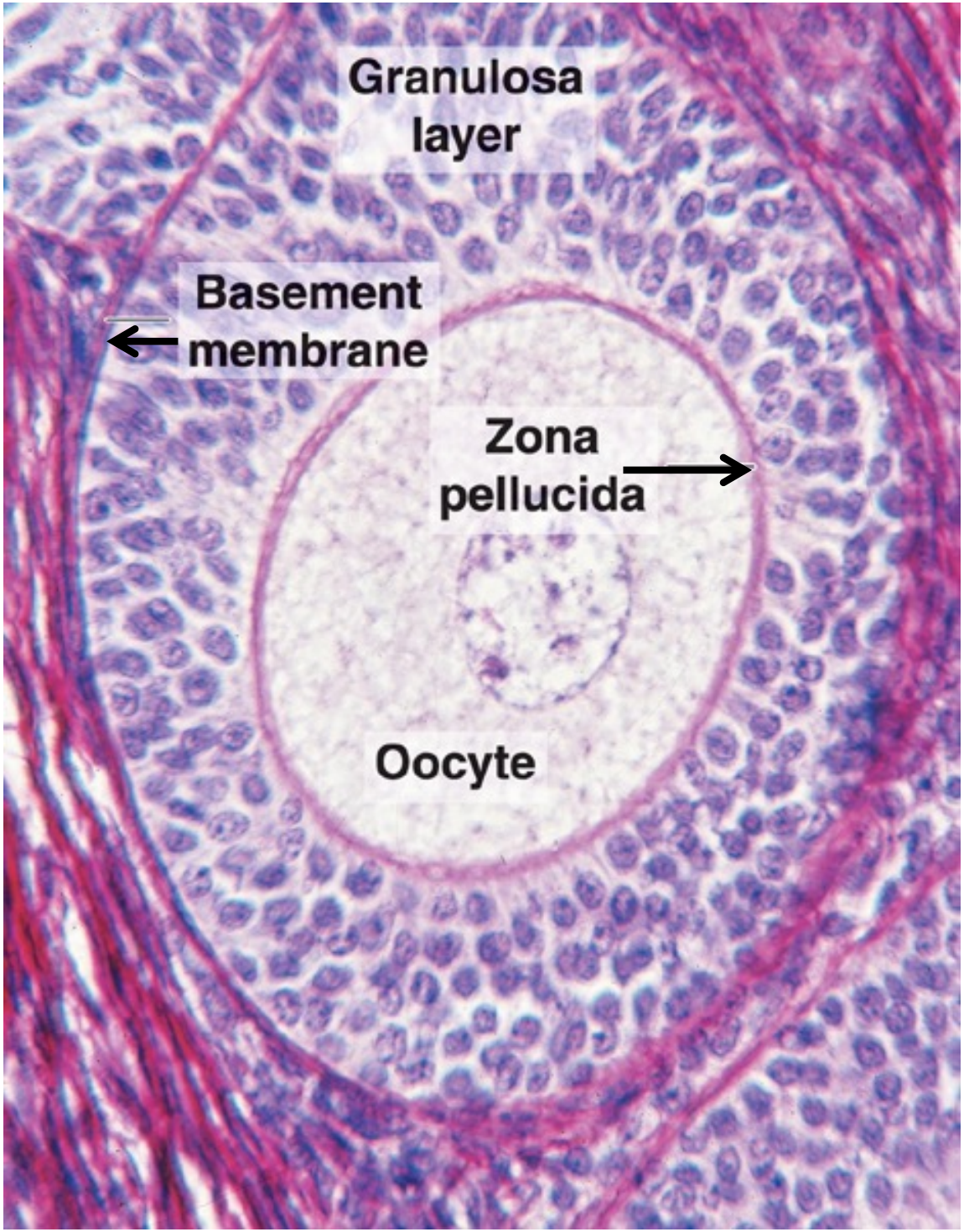


Primordial follicles

Primary oocyte is in prophase of first meiosis and is surrounded by flattened follicular cells.

Unilaminar primary follicle

Single layer of cuboidal follicular (granulosa) cells



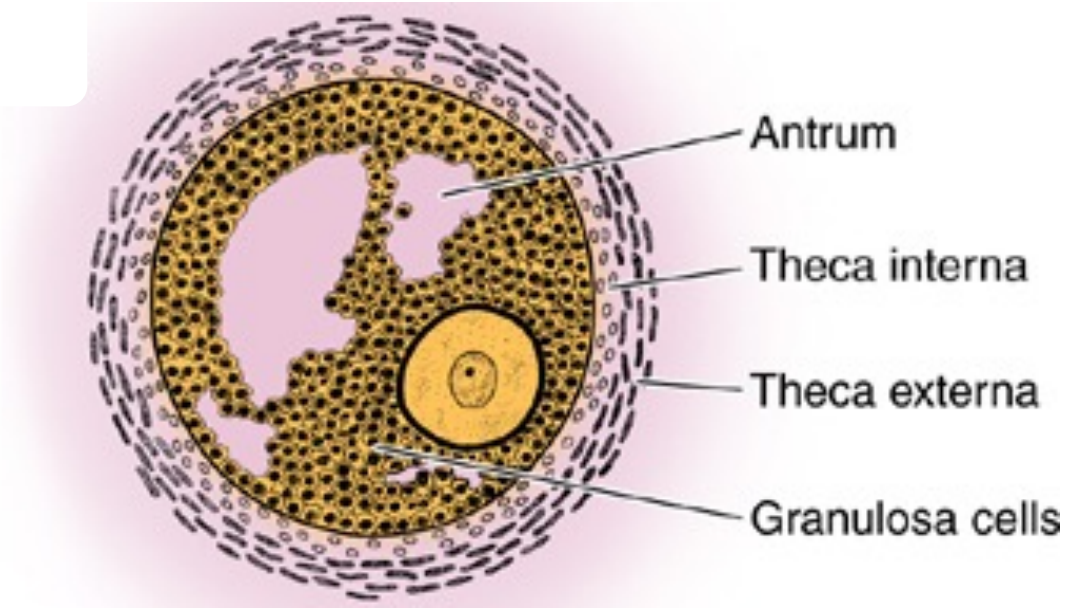
Multilaminar primary follicle

Multiple layers of granulosa cells.

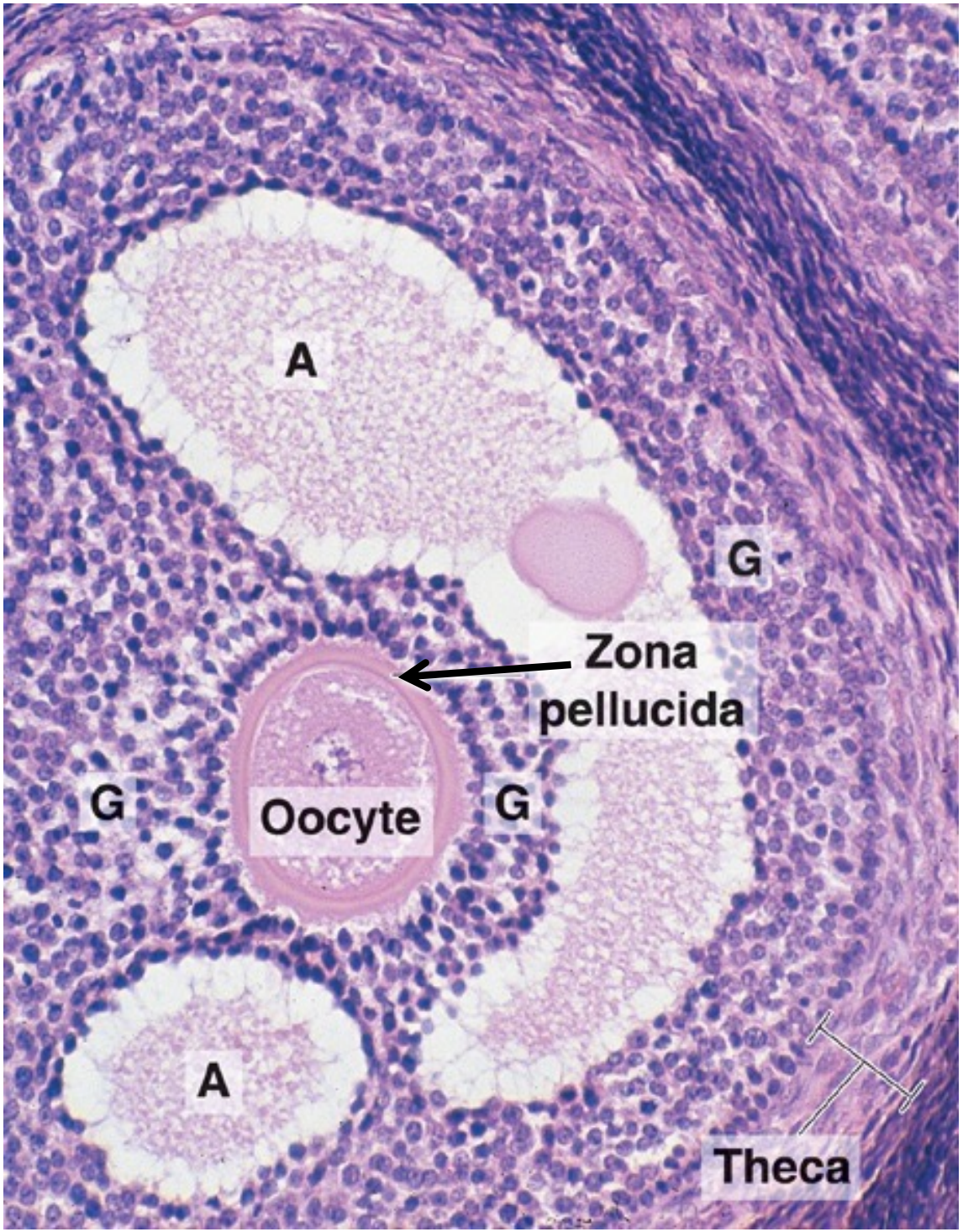
Prominent zona pellucida.

Theca interna cells developing from stromal fibroblasts.

Secondary (Antral) Follicle



- Oocyte still in prophase 1.
- Follicular fluid containing estrogen and precursors accumulates between granulosa cells, forming an antrum.
- Stromal cells differentiate into theca interna cells (produce estrogen precursors) and theca externa cells (smooth muscle cells and fibroblasts).



Secondary (Antral) Follicle

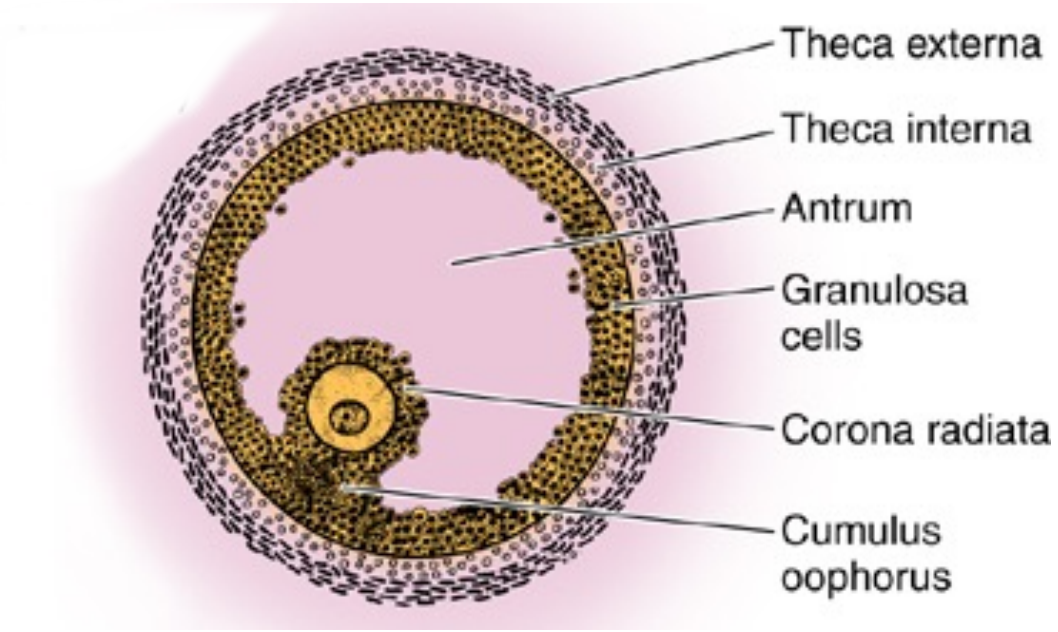
Antrum (A) containing follicular fluid.

Thick zona pellucida.

Well-formed theca:

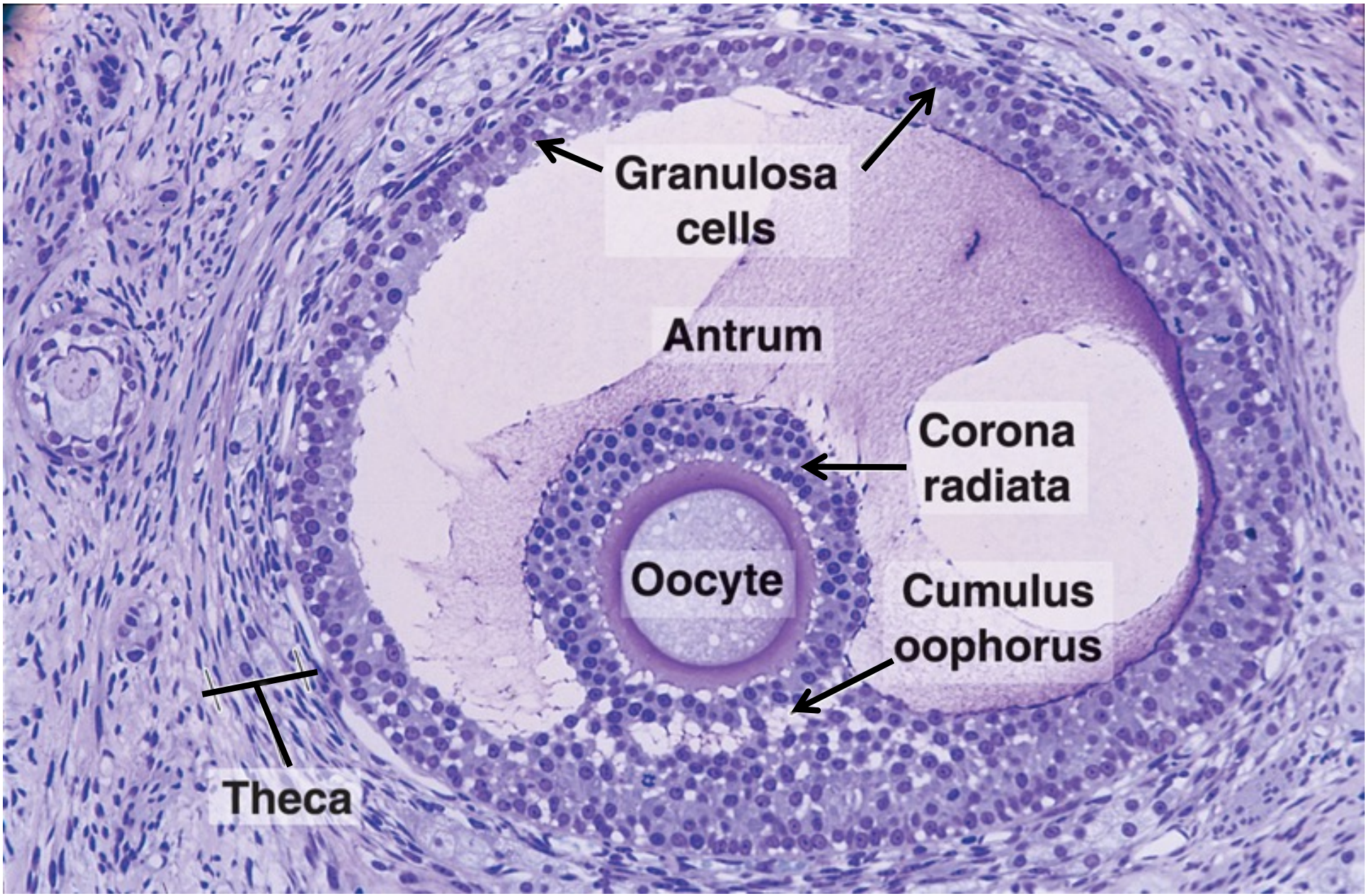
- Interna cells (more rounded)
- Externa cells (cigar-shaped)

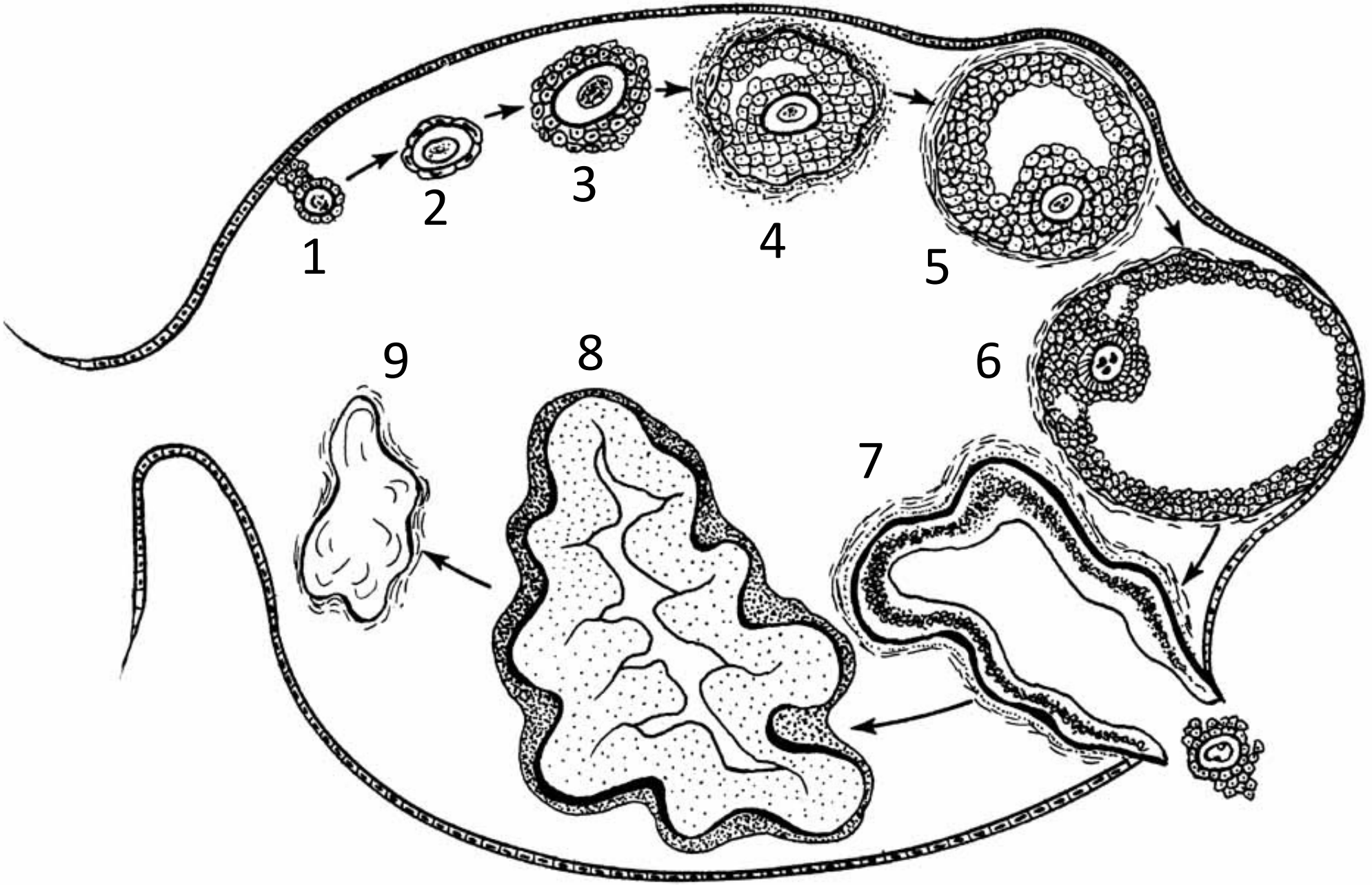
Mature (Graafian) Follicle



- Cumulus oophorus (a little pedestal of granulosa cells).
- Corona radiata (granulosa cells stuck to the oocyte).
- Antrum is symmetrical and contains follicular fluid.
- LH surge signals final maturation: resumption of meiosis to form 2° oocyte (arrested at metaphase II until fertilization).

Mature (Graafian) Follicle




1
2
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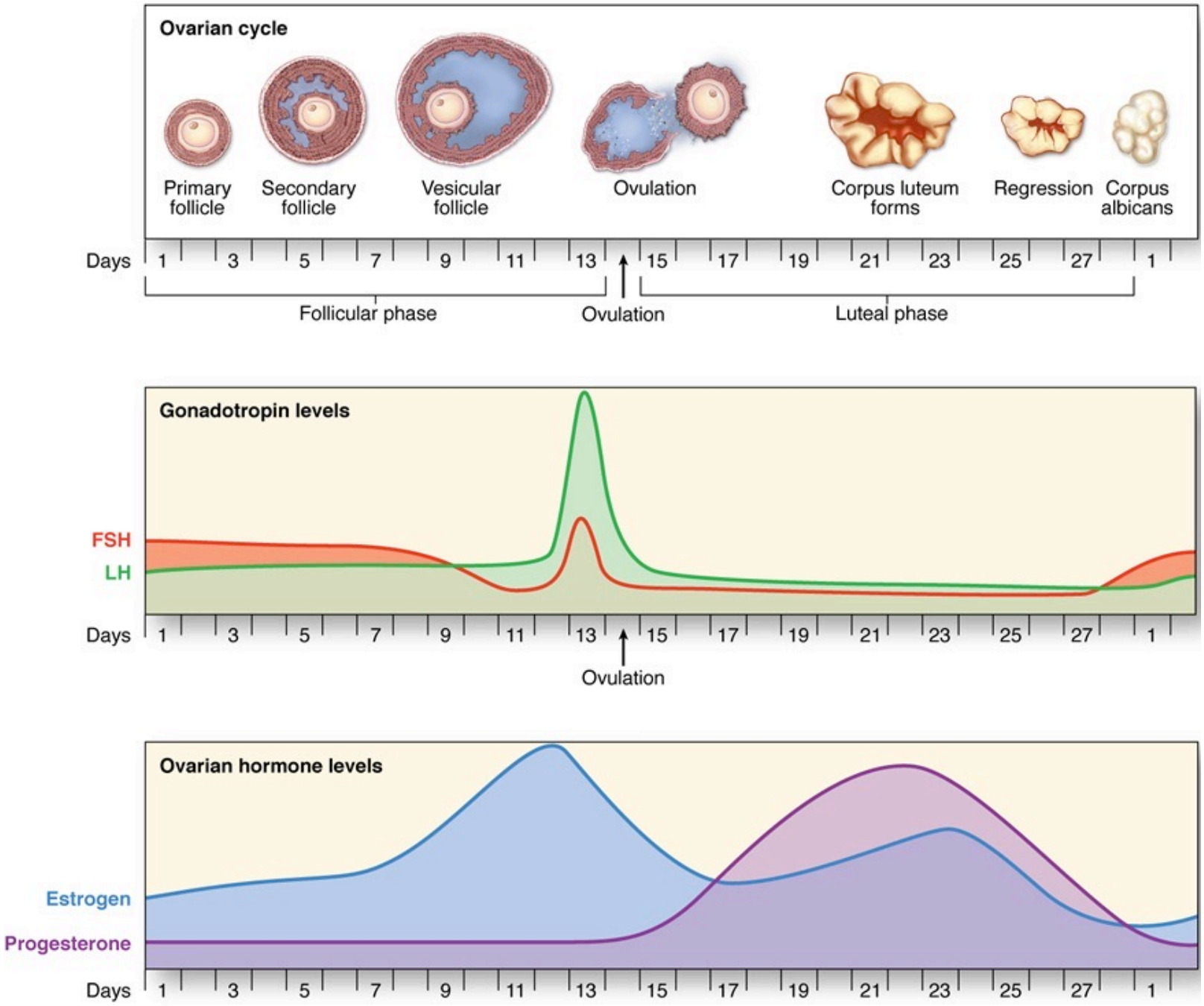
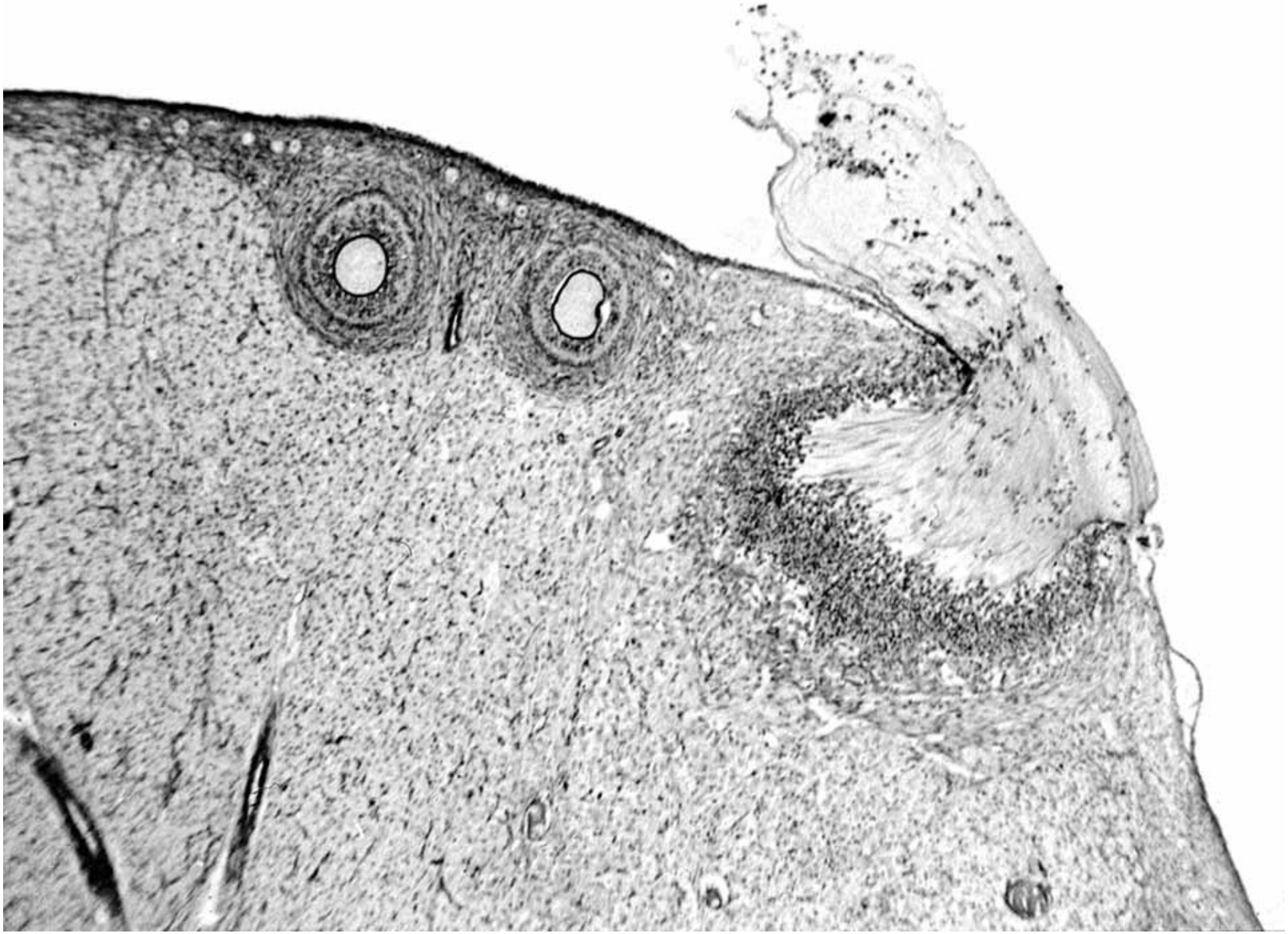


Ovarian structure and hormones during the menstrual cycle

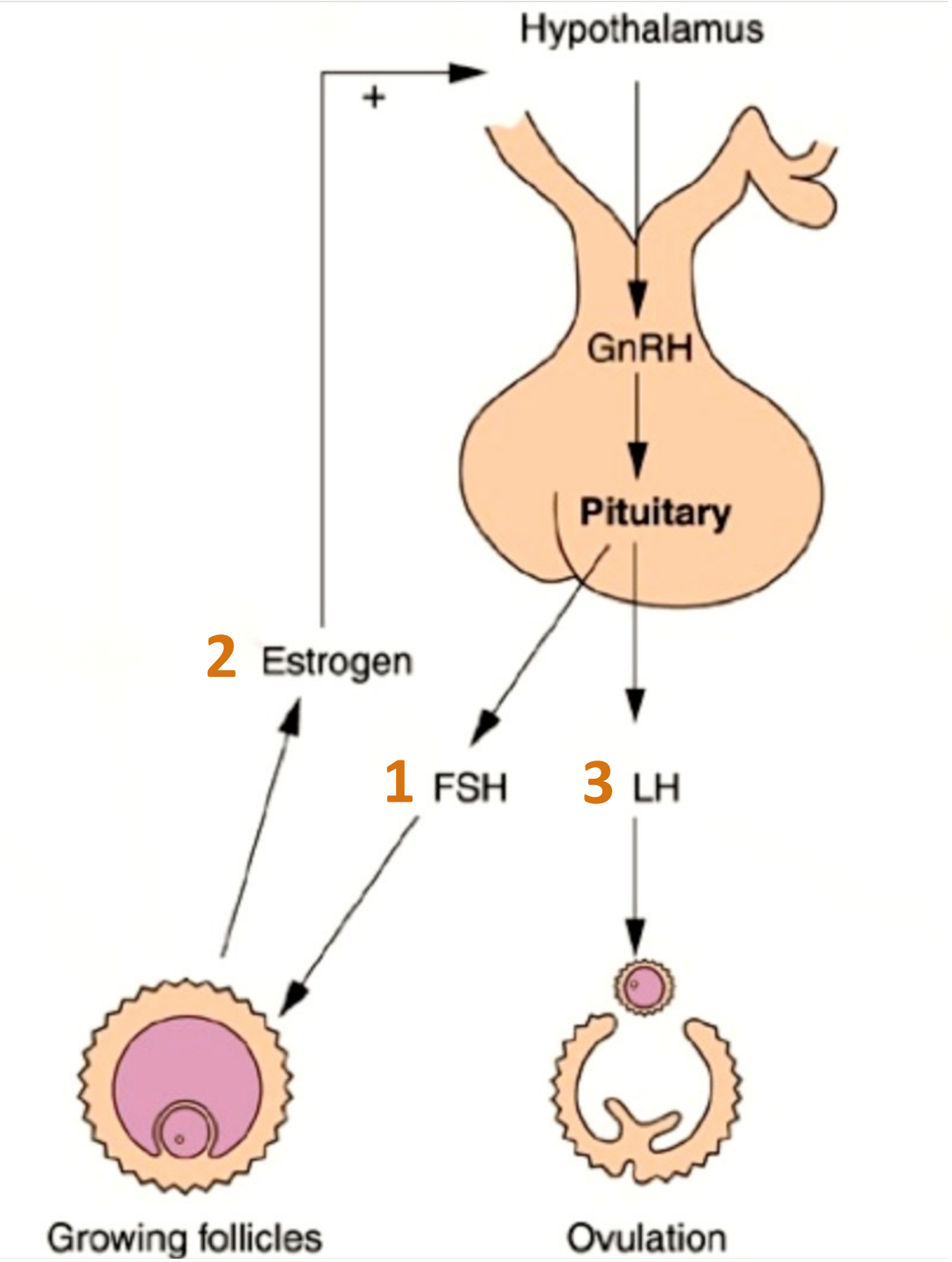
Ovulation

- During the first half of the menstrual cycle, FSH from anterior pituitary stimulates growth of ovarian follicles.
- Growing ovarian follicles secrete increasing levels of estrogen, precipitating a surge of LH from anterior pituitary on day 14, which causes ovulation.
- Edema and collagenases weaken the ovarian follicular wall, leading to rupture of ovarian surface.
- At ovulation the oocyte and corona radiata are expelled from ovary.



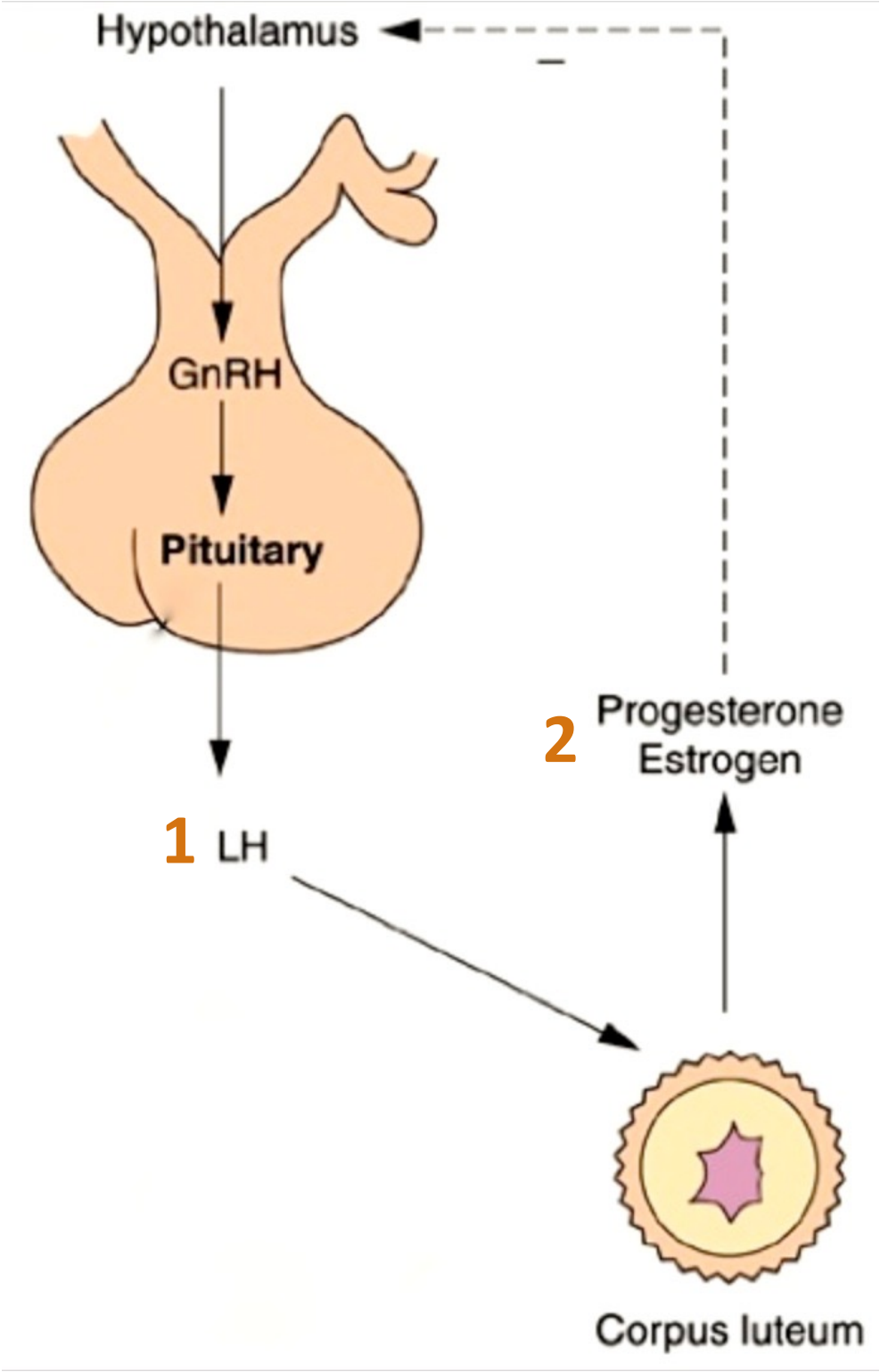
Sequence of events leading to ovulation:

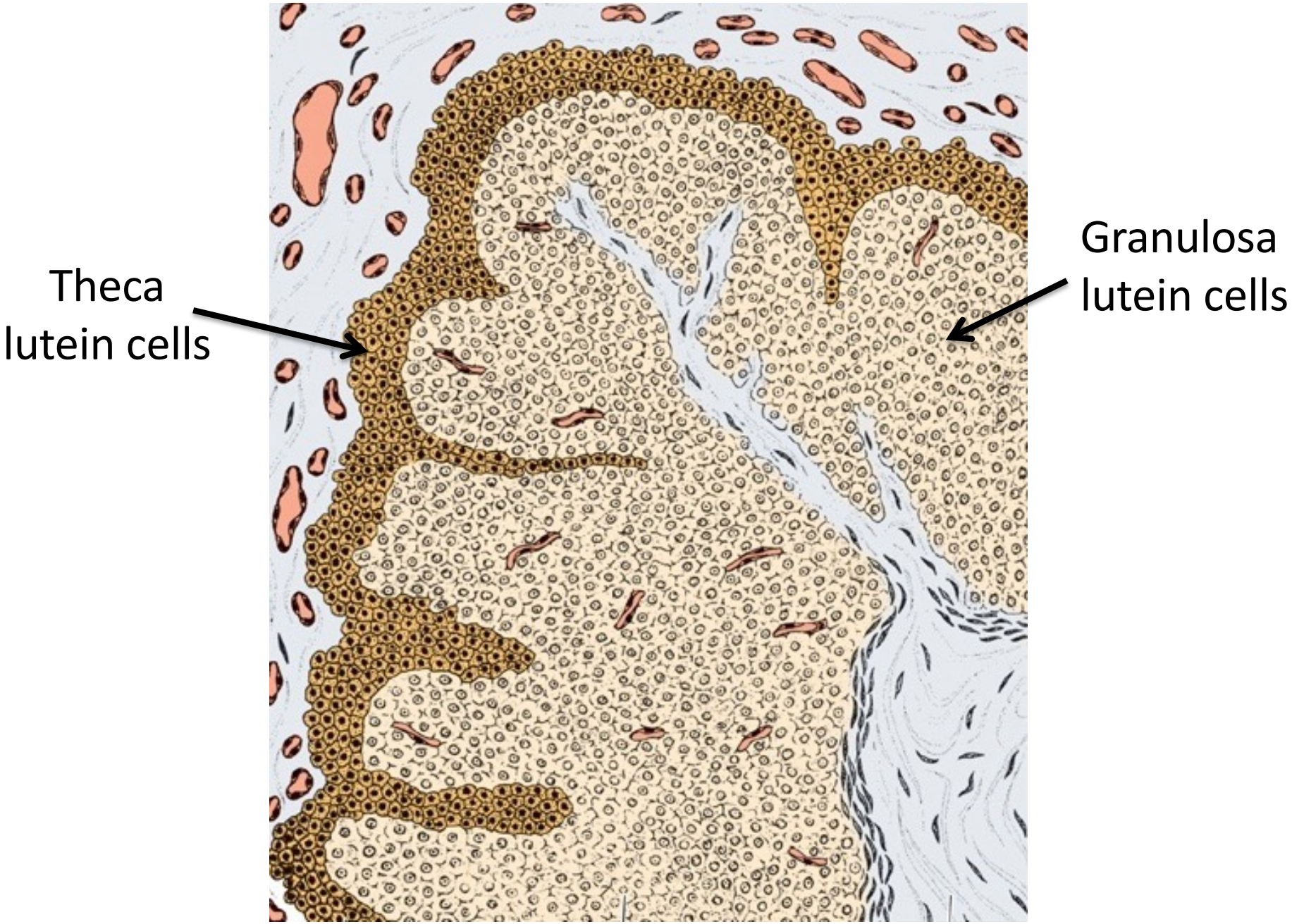
1. Pituitary secretes FSH which stimulates growth of follicles.
2. Follicles secrete increasing levels of estrogen, which precipitate an LH surge from pituitary.
3. LH causes rupture of follicle and release of oocyte.



Corpus Luteum

- After ovulation the granulosa cells and theca interna cells of ovulated follicle turn into a temporary endocrine organ called the corpus luteum.
- LH from the anterior pituitary causes:
  - granulosa cells to differentiate into granulosa lutein cells.
  - theca interna cells to differentiate into theca lutein cells.
  - Both new cell types produce progesterone and estrogen.


Hypothalamus
–
GnRH
Pituitary
2
Progesterone
Estrogen
1
LH
Corpus luteum



Structure of corpus luteum

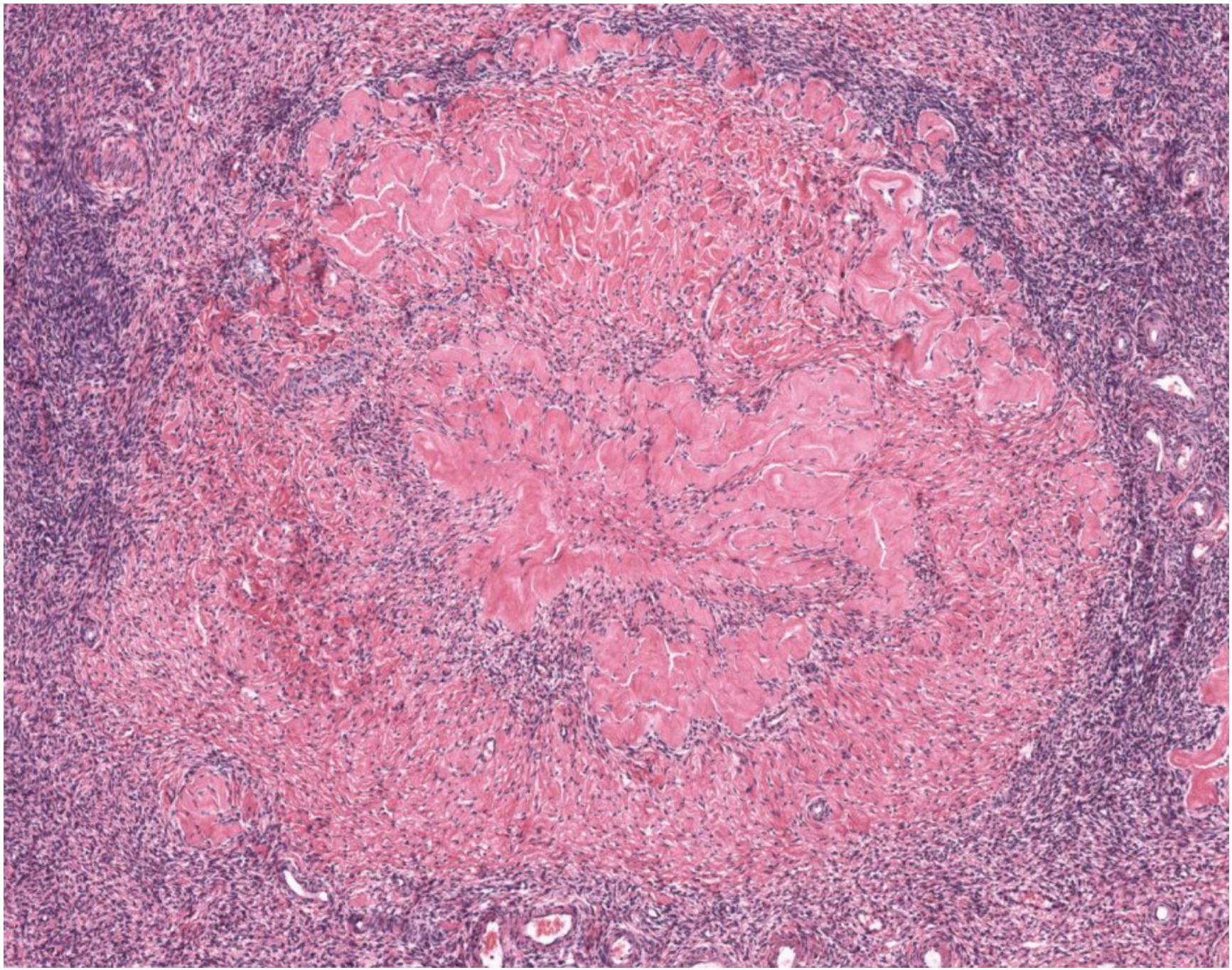
Two types of Corpus Luteum

Corpus luteum of menstruation

- Always forms at ovulation
- Lasts 14 days
- If embryo doesn't develop, it involutes, forming scar tissue (corpus albicans)

Corpus luteum of pregnancy

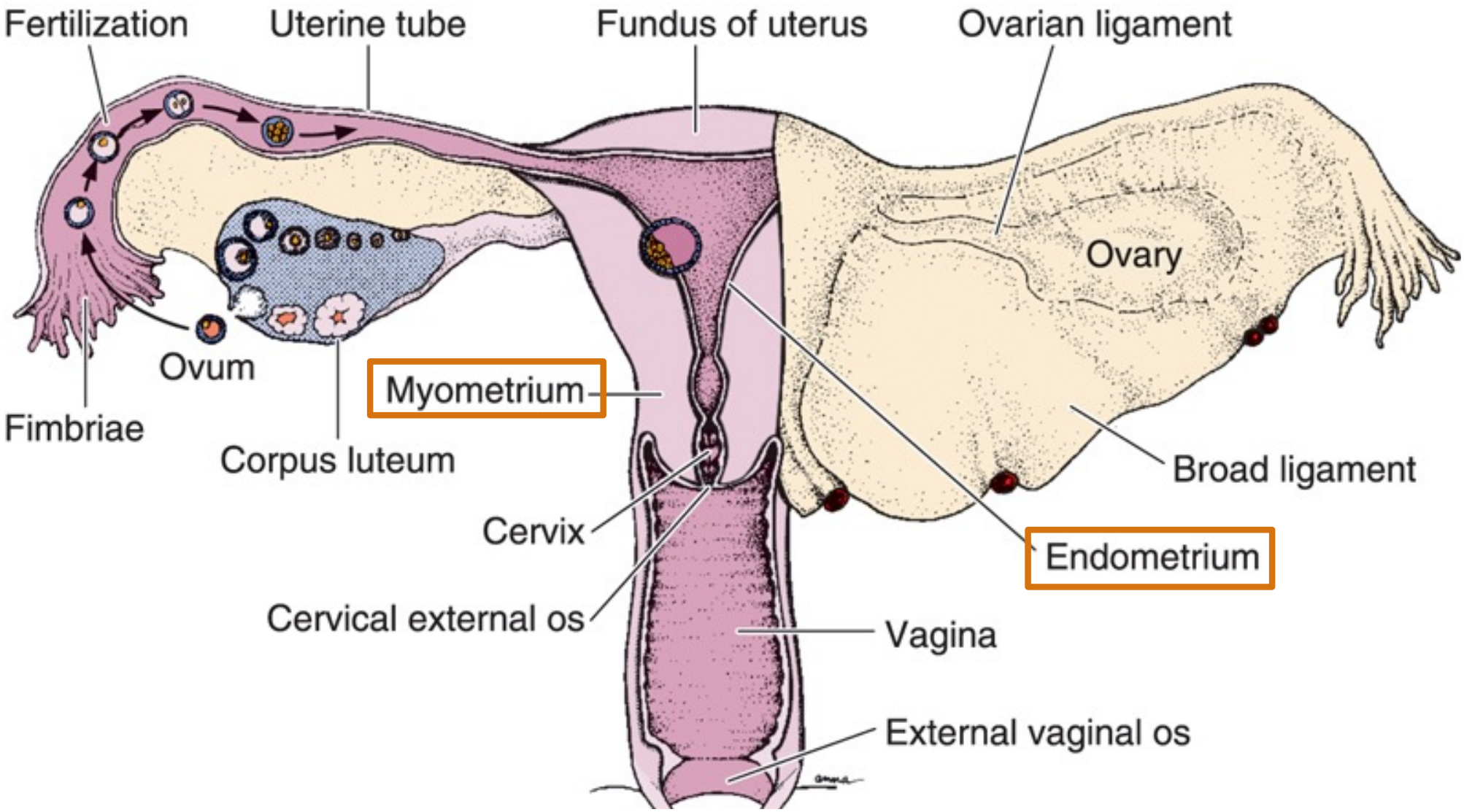
- Forms shortly after implantation
- Persists during first trimester
- Maintained by hCG produced by trophoblast
- Later, slowly involutes, forming corpus albicans



Corpus Albicans

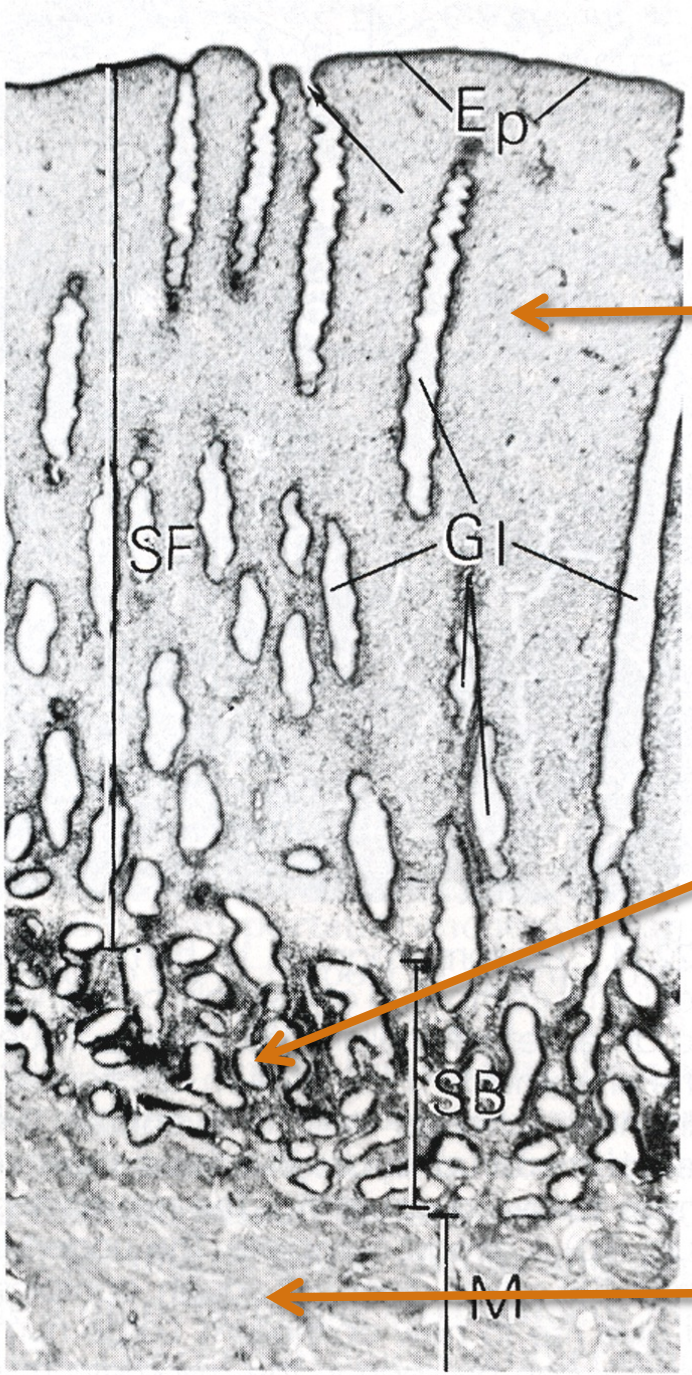
Female Reproductive System Lecture Outline

- Ovary
- Uterus



Layers of the Uterus

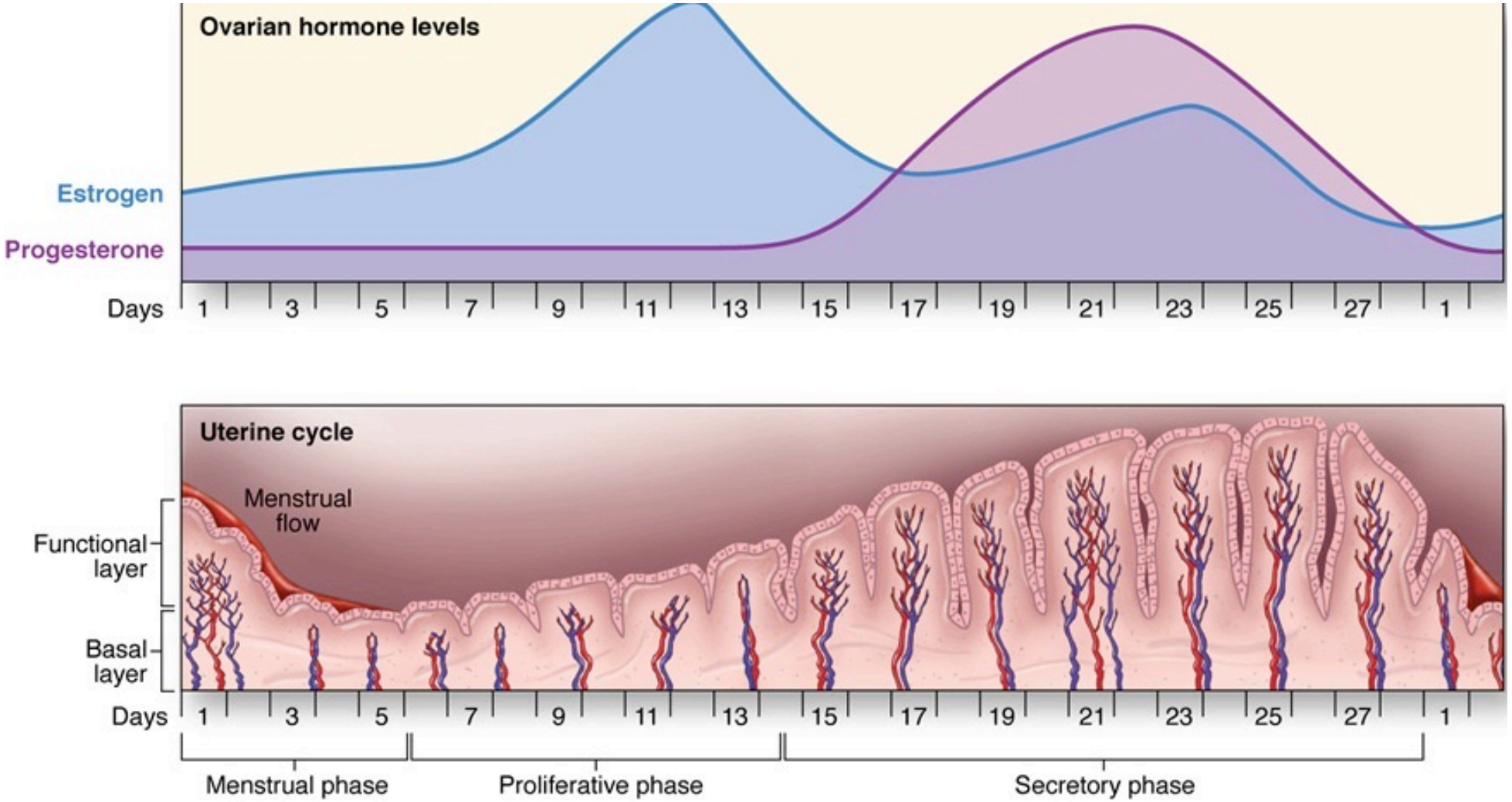
Endometrium



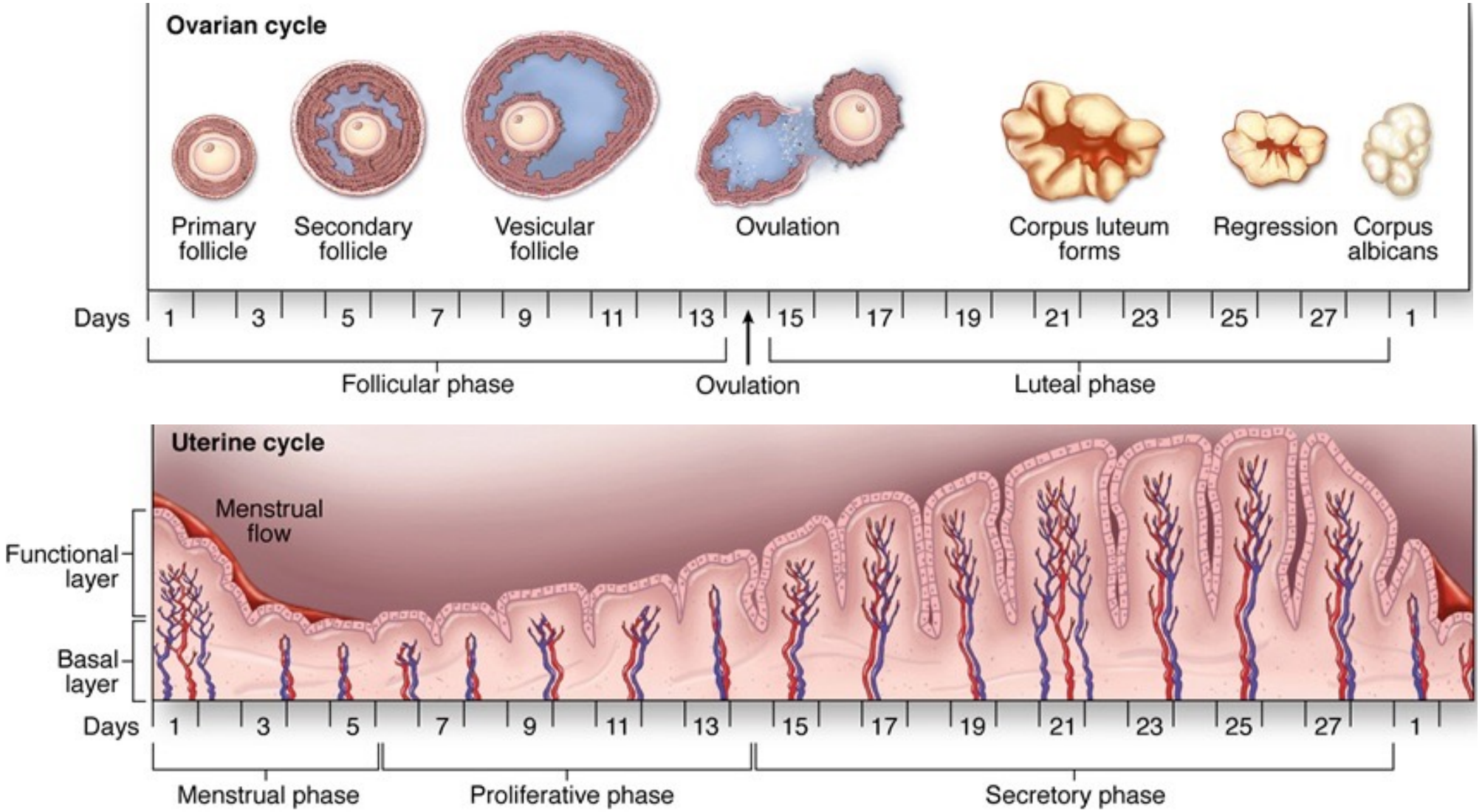
Functionalis glands:
Sloughed during menstruation

Basalis glands:
Regenerate glands after menstruation

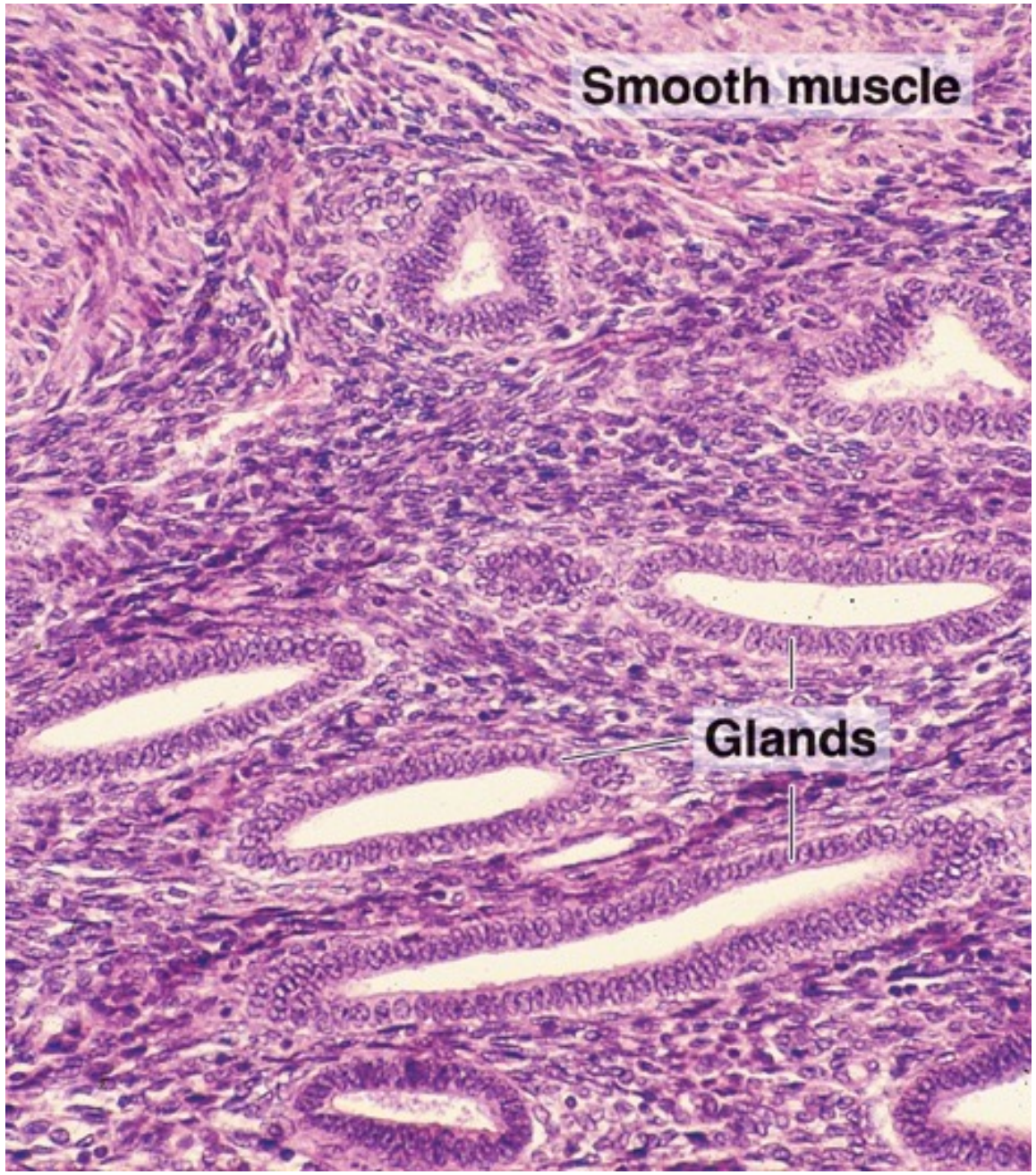
Myometrium:
Smooth muscle layer of uterine wall



Correlation of ovarian hormones and structure of endometrial glands during the menstrual cycle



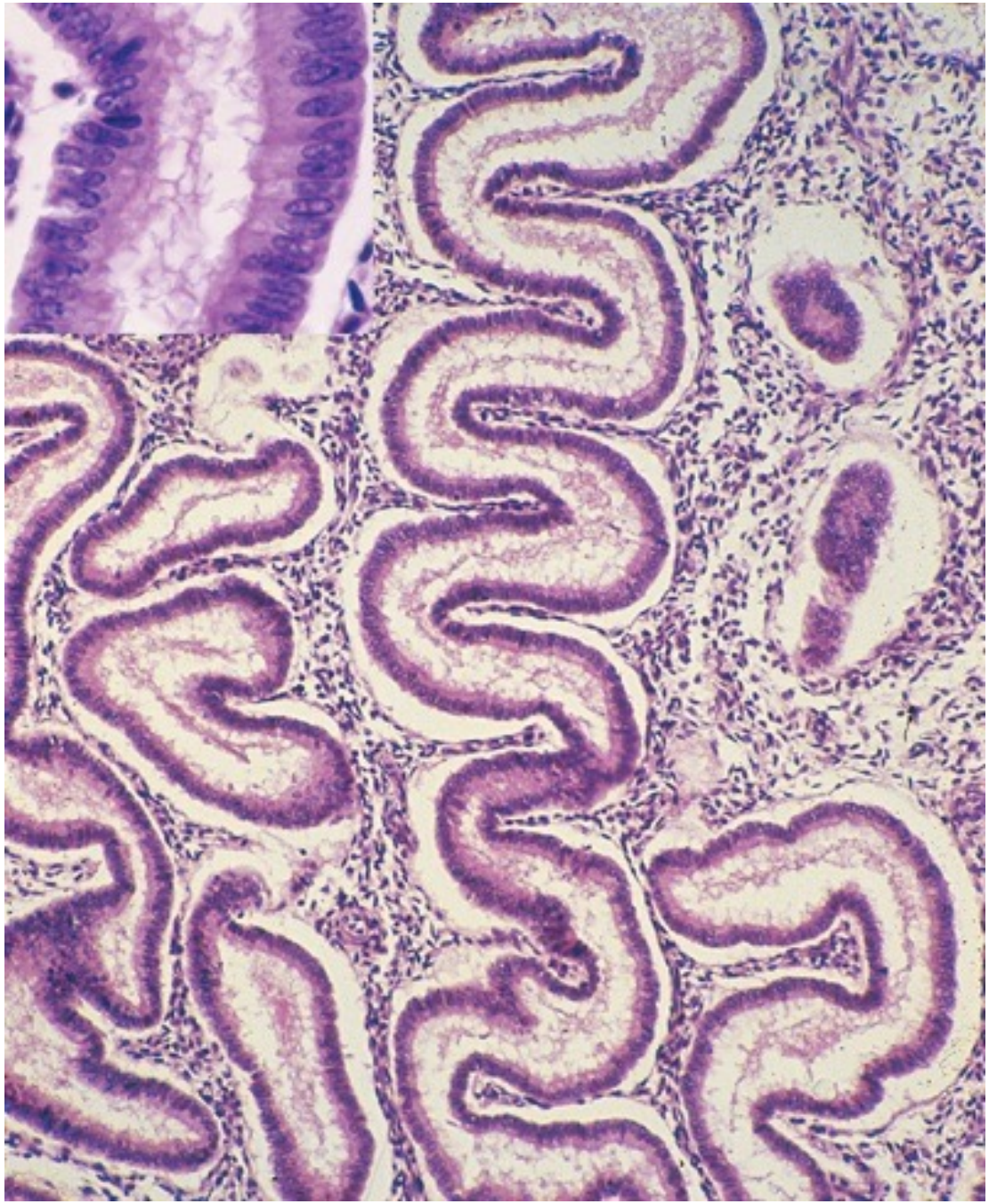
Ovarian and endometrial changes during the menstrual cycle



Proliferative phase occurs during first half of menstrual cycle under influence of estrogen.

Glands are straight and narrow with minimal secretory activity.

Endometrium during proliferative phase



Secretory phase occurs during second half of menstrual cycle under influence of progesterone.

Glands are tortuous, wide and filled with secretory product.

Endometrium during secretory (luteal) phase

Menstruation

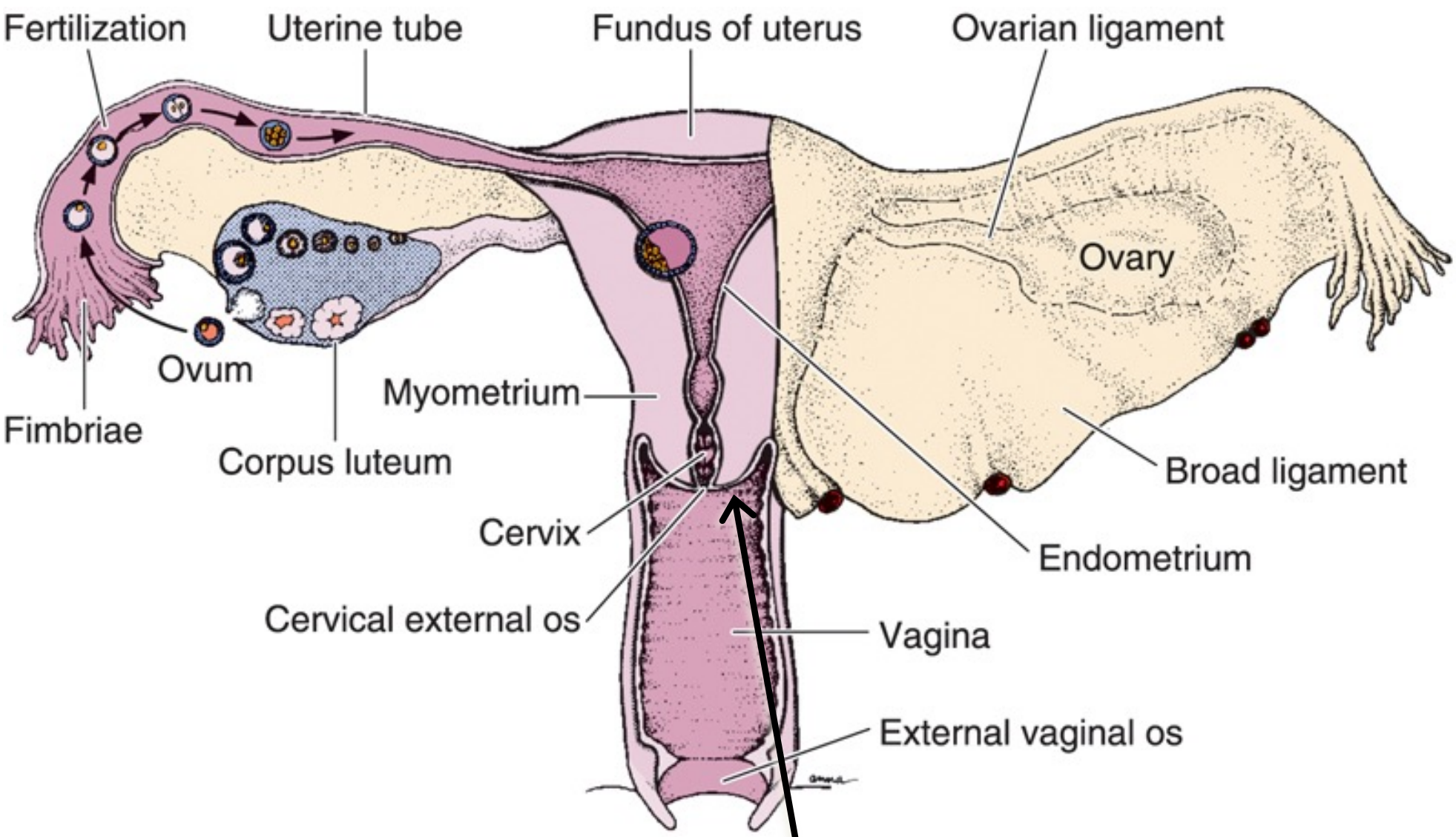
- Occurs due to degeneration of the corpus luteum resulting in loss of estrogen and progesterone production.
- Constriction of spiral arteries in uterus causes ischemia (loss of oxygen) and tissue necrosis (death) in the upper layer of the endometrium.
  Blood and necrotic tissue are released.
- Bottom layer remains viable and regenerates endometrial glands during the next cycle under influence of estrogen.

Summary of events of menstrual cycle

	Pituitary hormones	Ovarian events	Ovarian hormones	Endometrium events
Menstrual phase Days 1-5				Shedding of part of mucosa 14 days after ovulation
Proliferative phase Days 6-14	FSH	Rapid growth of follicles	Follicles produce estrogen, which acts on vagina, tubes, uterus	Growth of mucosa after menstruation
Secretory phase Days 14-28	LH peak (stimulated by estrogen!)	Ovulation (day 14), corpus luteum formation and degeneration	Progesterone (from corpus luteum). Progesterone decreases if no pregnancy.	Growth of mucosa, coiling of glands, secretion

Female Reproductive System Lecture Outline

- Ovary
- Uterus
- Cervix

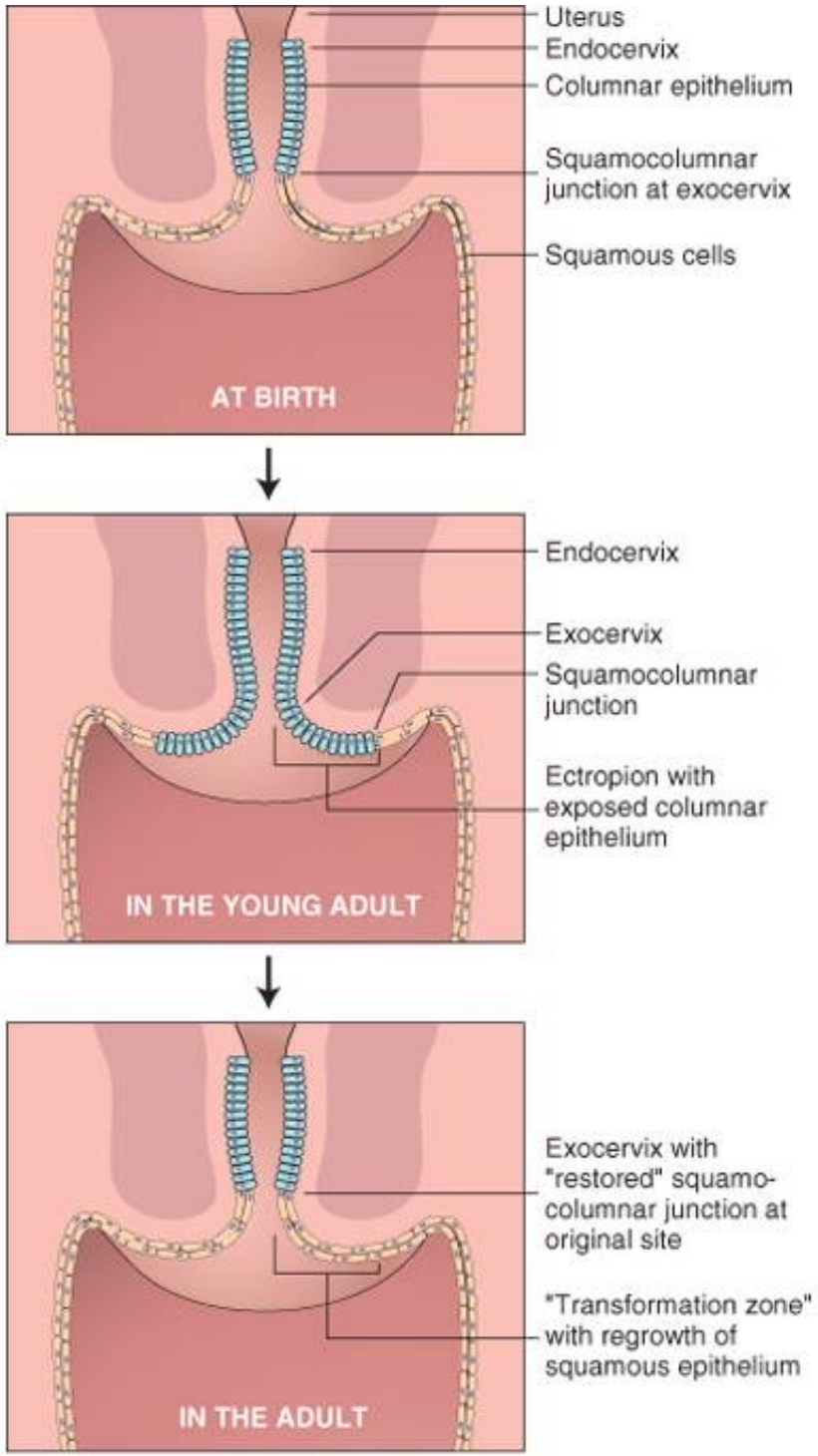

Fertilization
Uterine tube
Fundus of uterus
Ovarian ligament
Ovary
Ovum
Fimbriae
Corpus luteum
Myometrium
Broad ligament
Cervix
Endometrium
Cervical external os
Vagina
External vaginal os
Uterine cervix

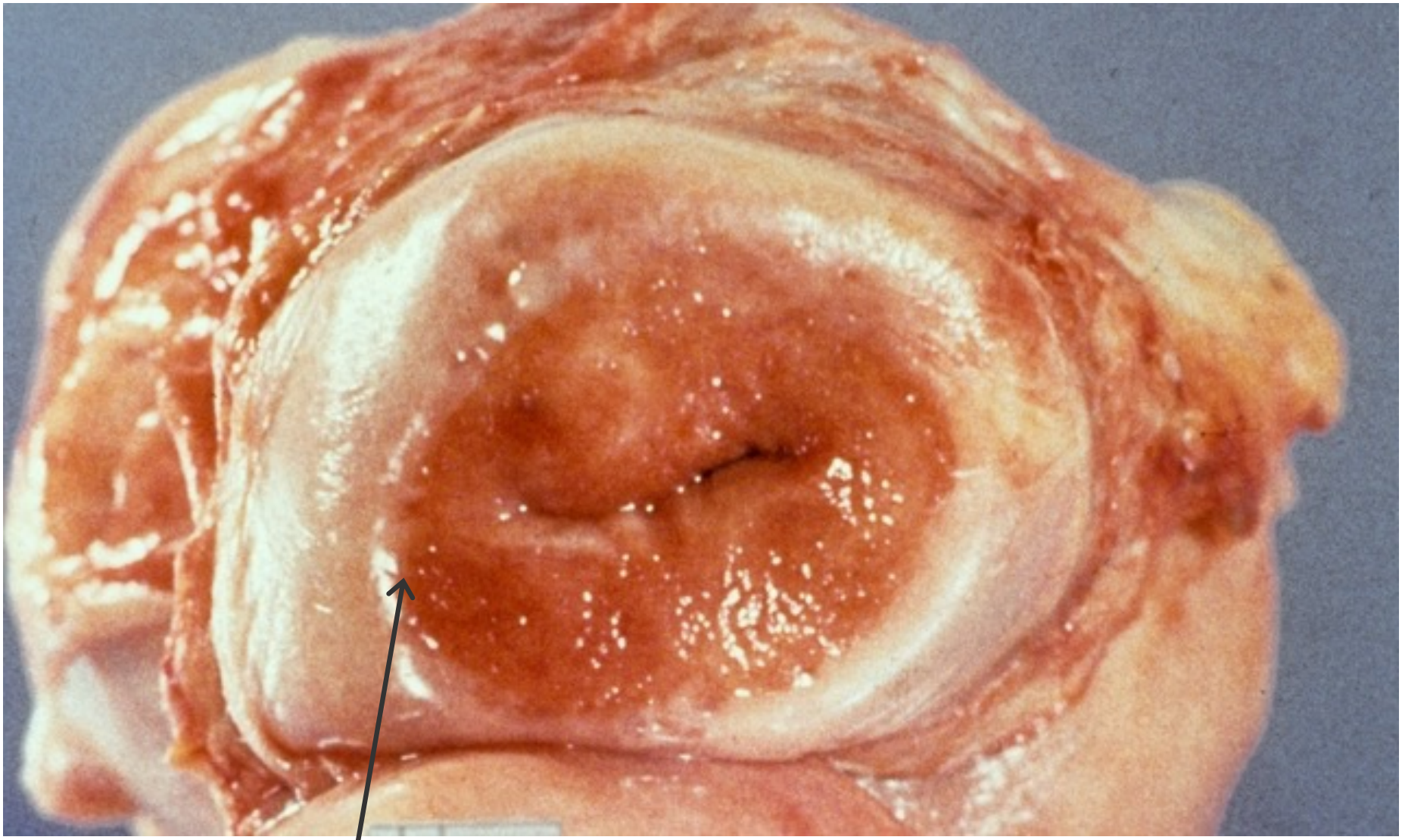
Cervical transformation zone

Abrupt change from simple columnar to stratified squamous epithelium.

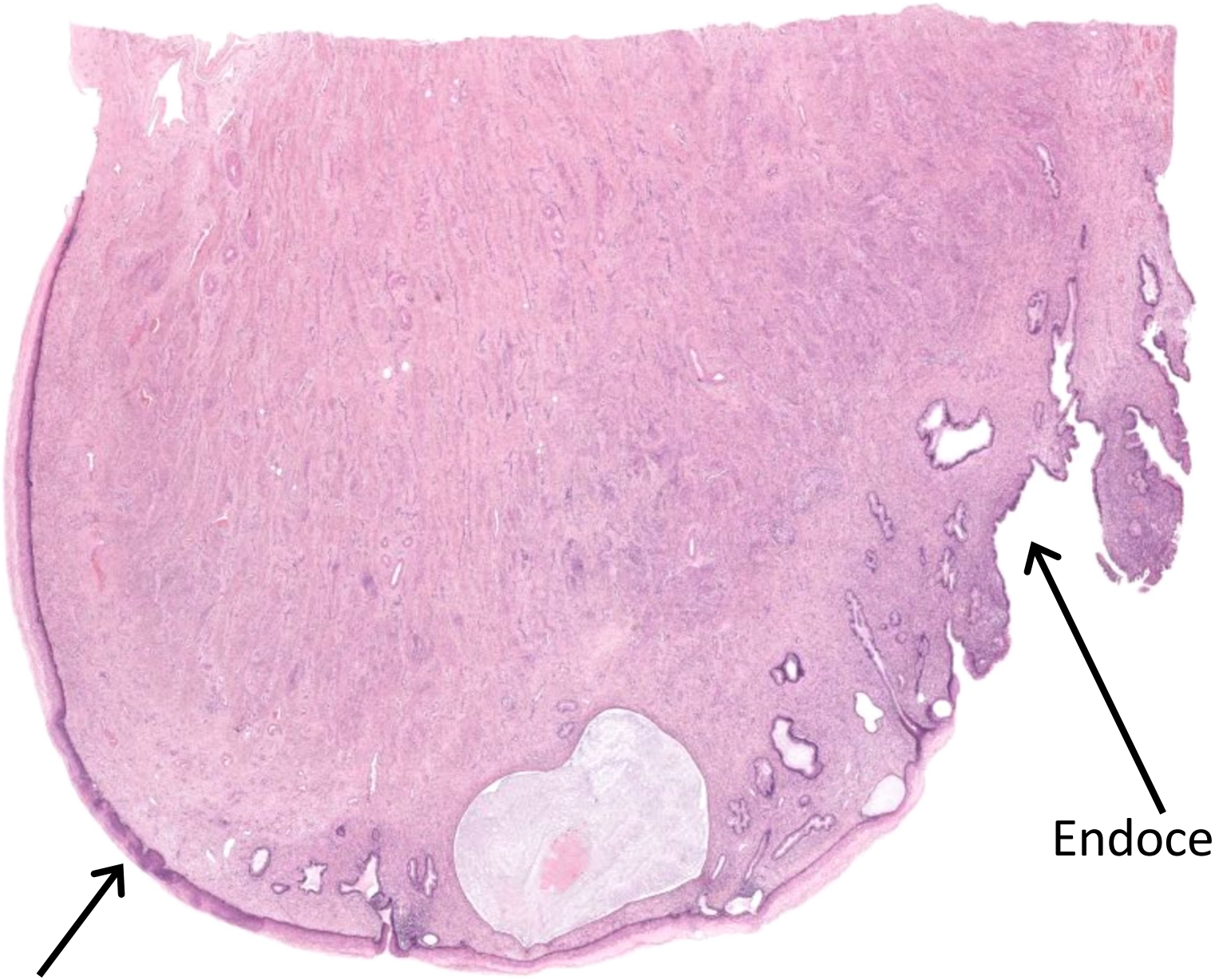
In general: ectocervix is squamous, endocervix is columnar.

Exact location of the transformation zone changes with age!

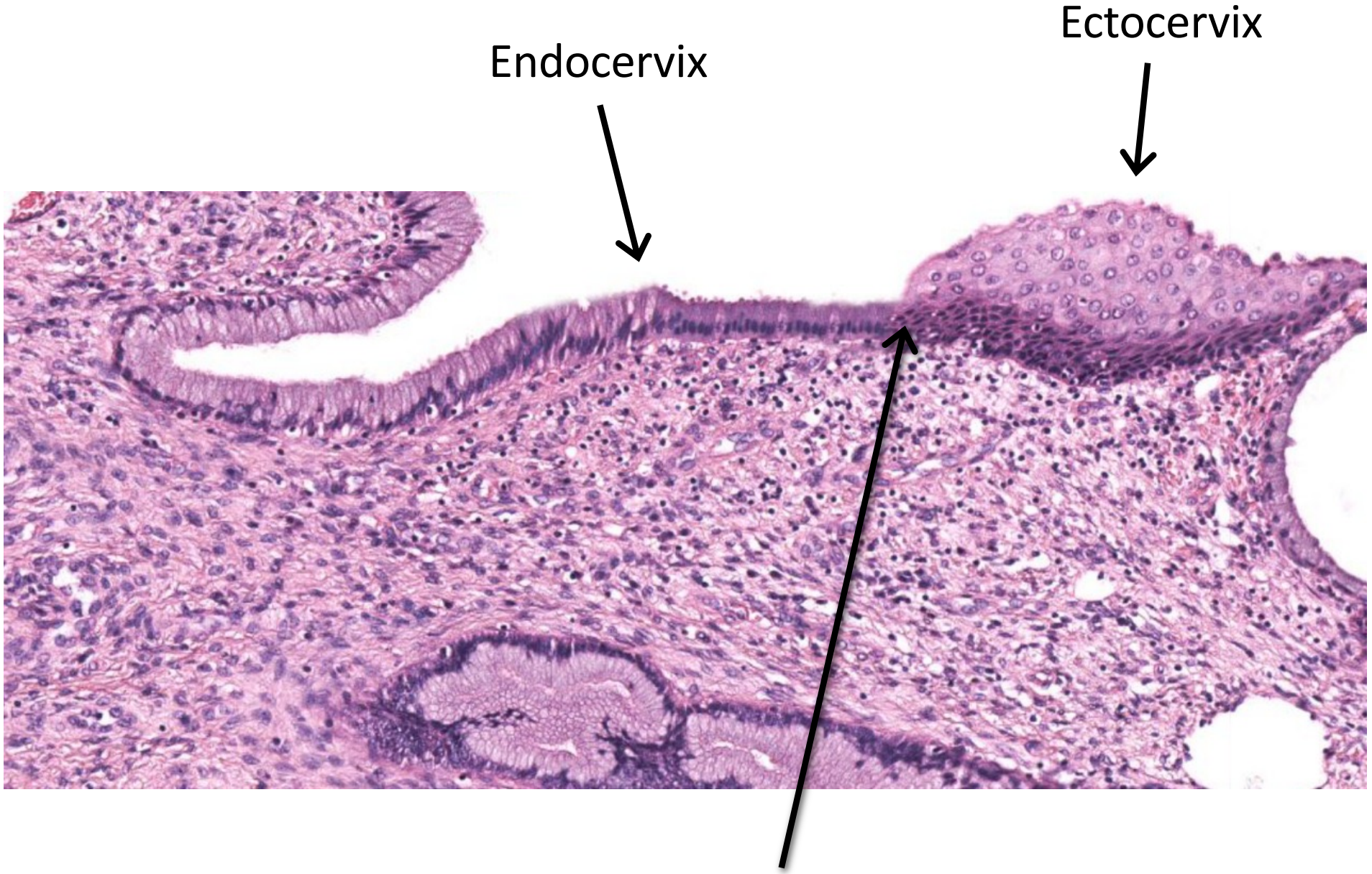




Normal cervix, young adult



Uterine cervix


Endocervix
Ectocervix
Transformation zone

Female Reproductive System Lecture Outline

- Ovary
- Uterus
- Cervix