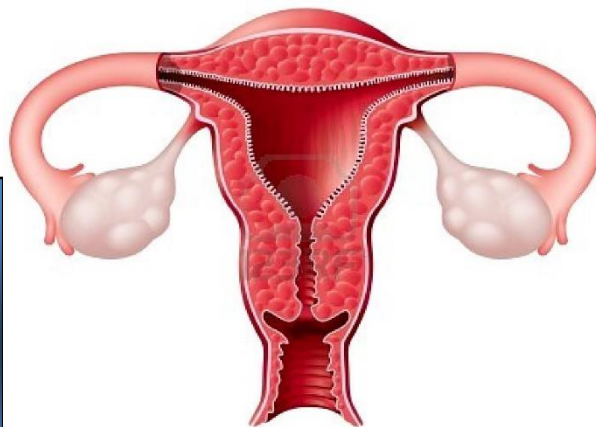


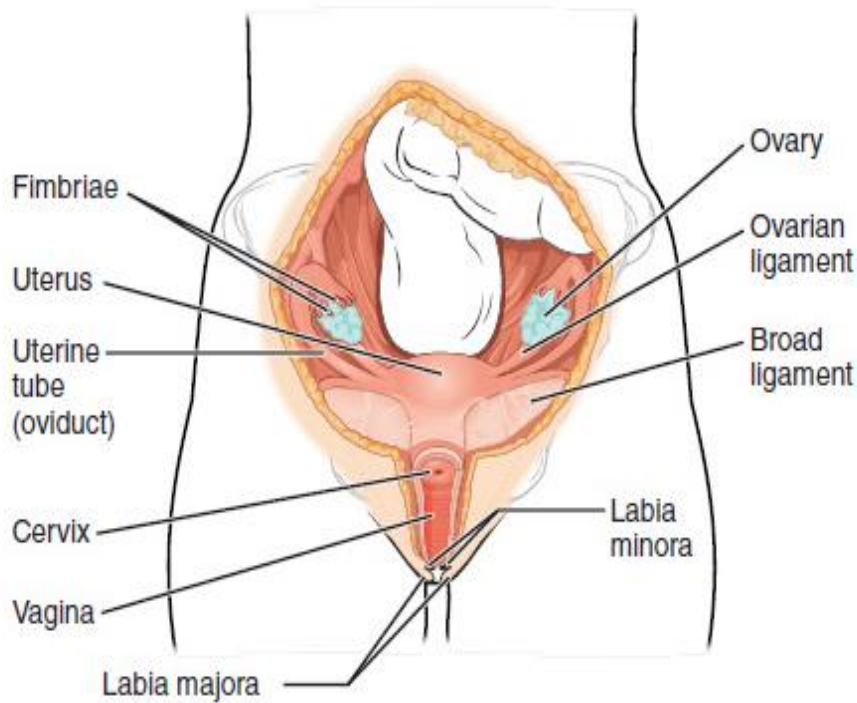
# Female reproductive system

Department of Histology and Embryology  
Poznan University of Medical Sciences



**2020/2021**

## The female reproductive (genital) system consists of



Female reproductive system – anterior view

### the internal sex organs

- oviducts (Fallopian tubes)
- uterus
- vagina
- ovaries

### the external sex organs

(genitals or vulva)

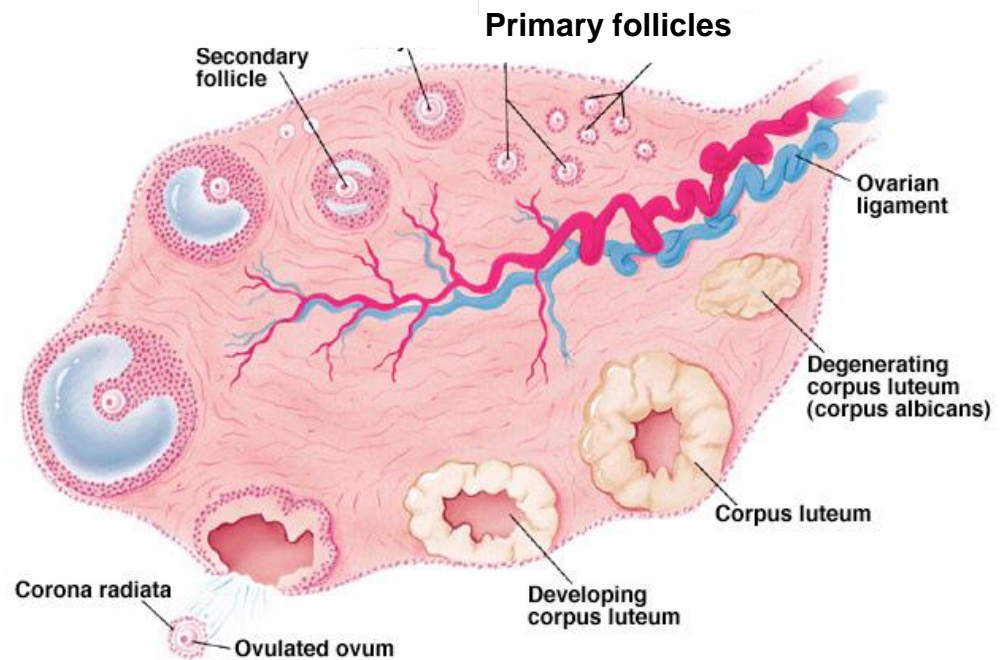
- labia (minora and majora)
- clitoris
- vaginal opening

This system is **immature at birth** and develops to **maturity at puberty**.

Mature FRS is able to **produce oocytes** and to **create conditions for fetal development** .

# Ovary

- consists of a cortical and medullar regions
- the surface of the ovary is covered by a **simple cuboidal epithelium** – the germinal epithelium
- under the germinal epithelium – **tunica albuginea** – layer of dense irregular connective tissue



# Cortex and medulla of ovary

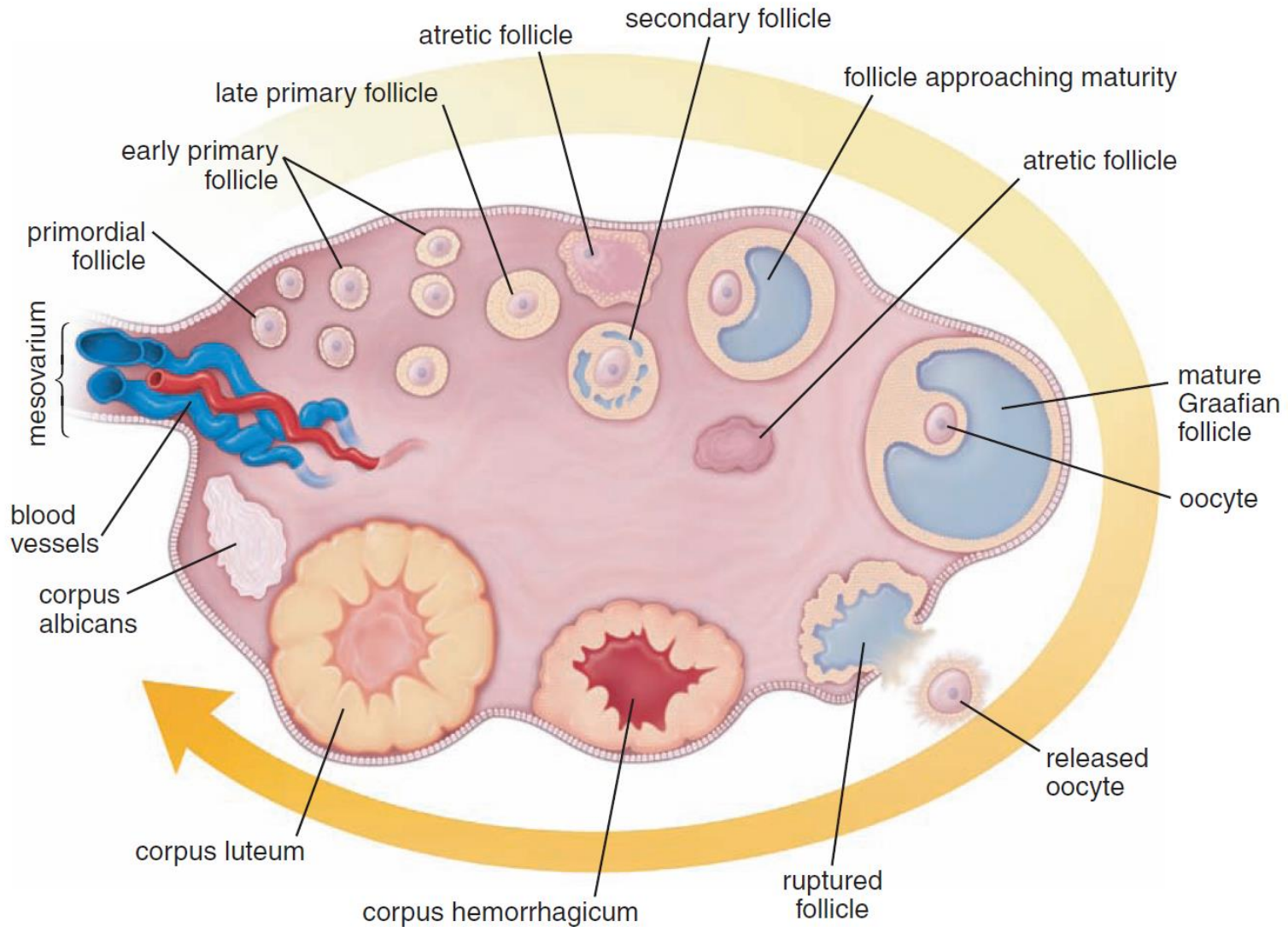
## **CORTICAL REGION (CORTEX):**

- the stroma composed from connective tissue
- contains numerous ovarian follicles in various stages of development
- ovarian follicle consists of an oocyte surrounded by one or more layers of follicular cells – the granulosa cells

## **MEDULLARY REGION (MEDULLA):**

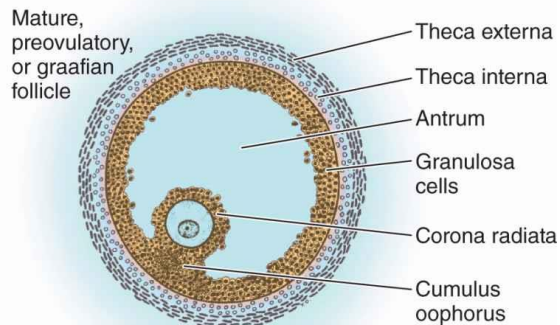
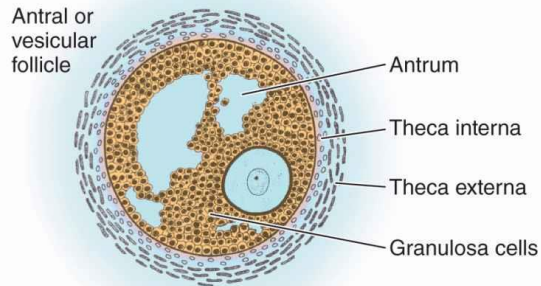
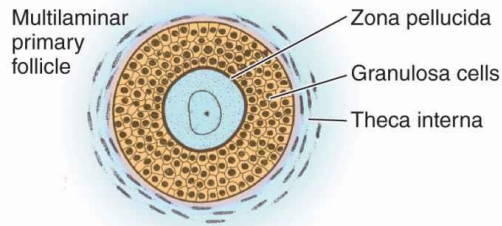
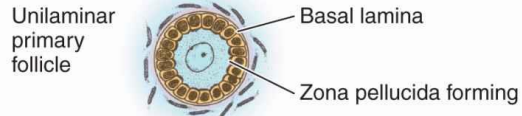
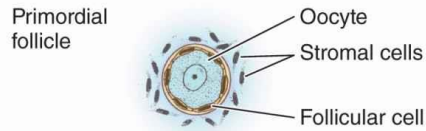
- loose connective tissue ; It forms from embryonic mesenchyme and contains blood vessels, lymphatic vessels, and nerves.

# Ovarian overall structure



**FIGURE 23.2 • Schematic drawing of a section through the ovary.** This drawing shows stages of follicular development from the early primary follicle to the mature (Graafian) follicle. The maturation of the follicles occurs in the direction of the arrow. Changes in the follicle after ovulation lead to development of the corpus luteum and eventually the corpus albicans. Note the highly coiled blood vessels in the hilum and medulla of the ovary.

# Stages of ovarian follicles



## 1. Primordial follicles

## 2. Primary follicles

### 2.1. Unilaminar primary follicles

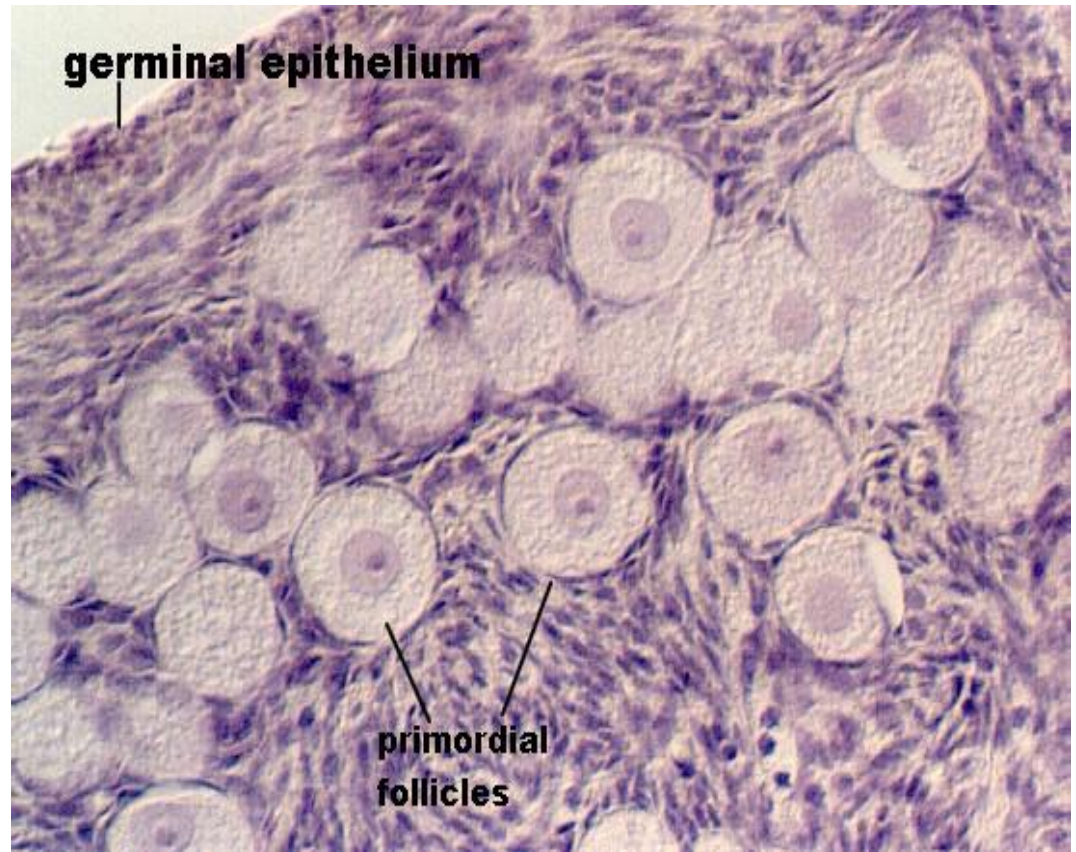
### 2.2. Multilaminar primary follicles

## 3. Secondary (antral) follicles

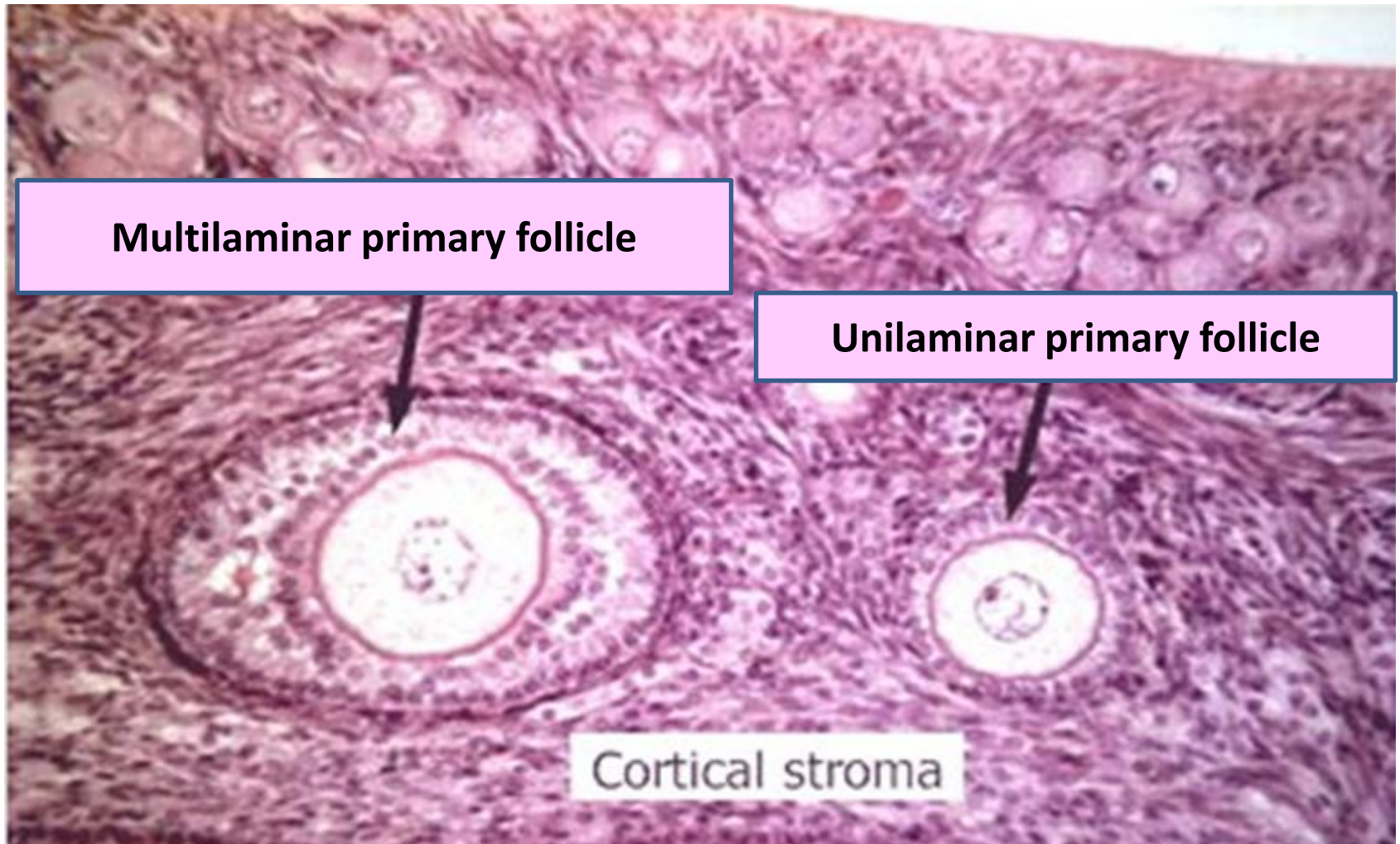
## 4. Mature (Graafian) follicles

# Primordial follicles

- Primordial follicles consist of a primary oocyte surrounded by a layer of squamous **follicular cells**

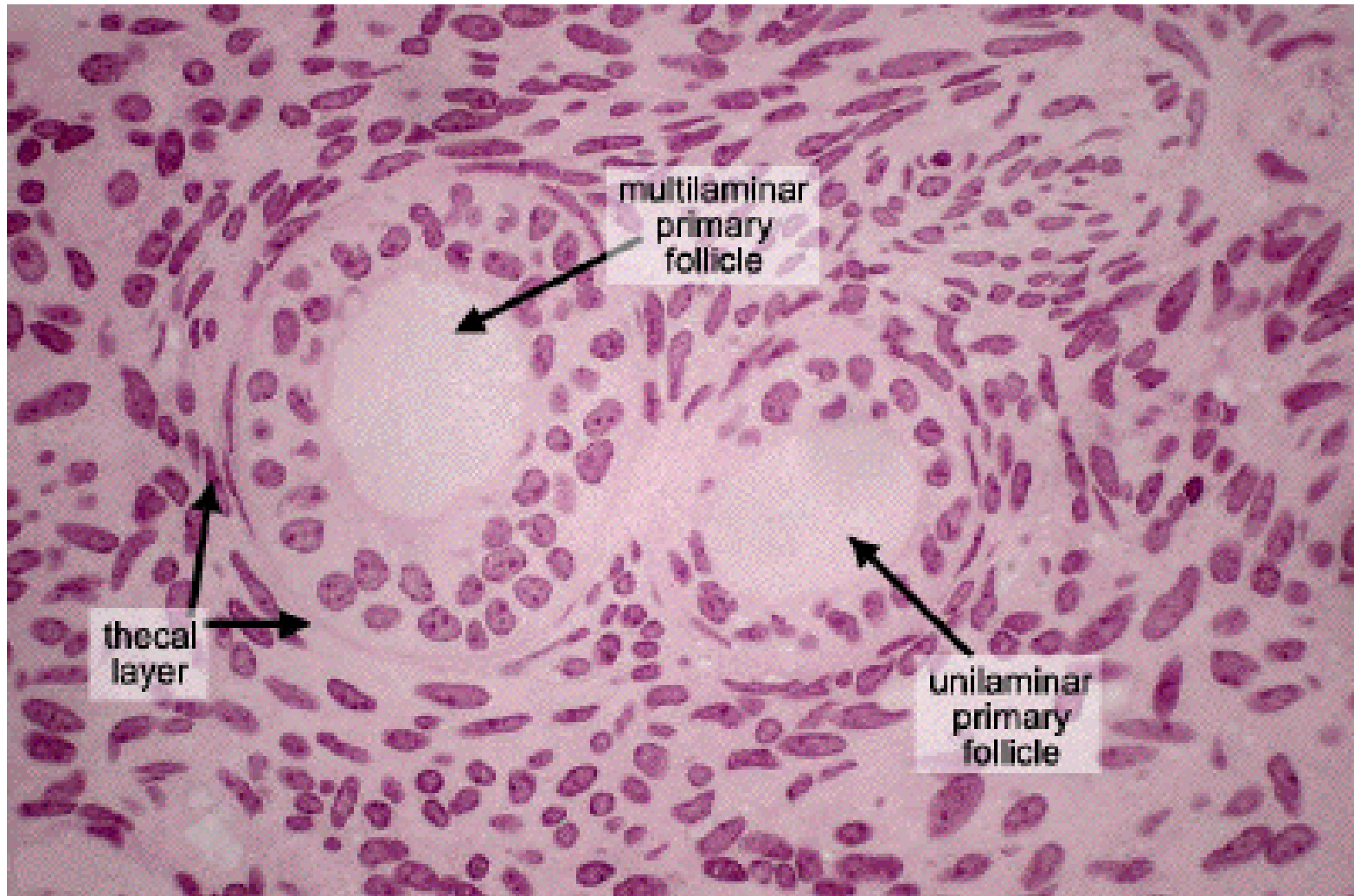


# Primary follicles

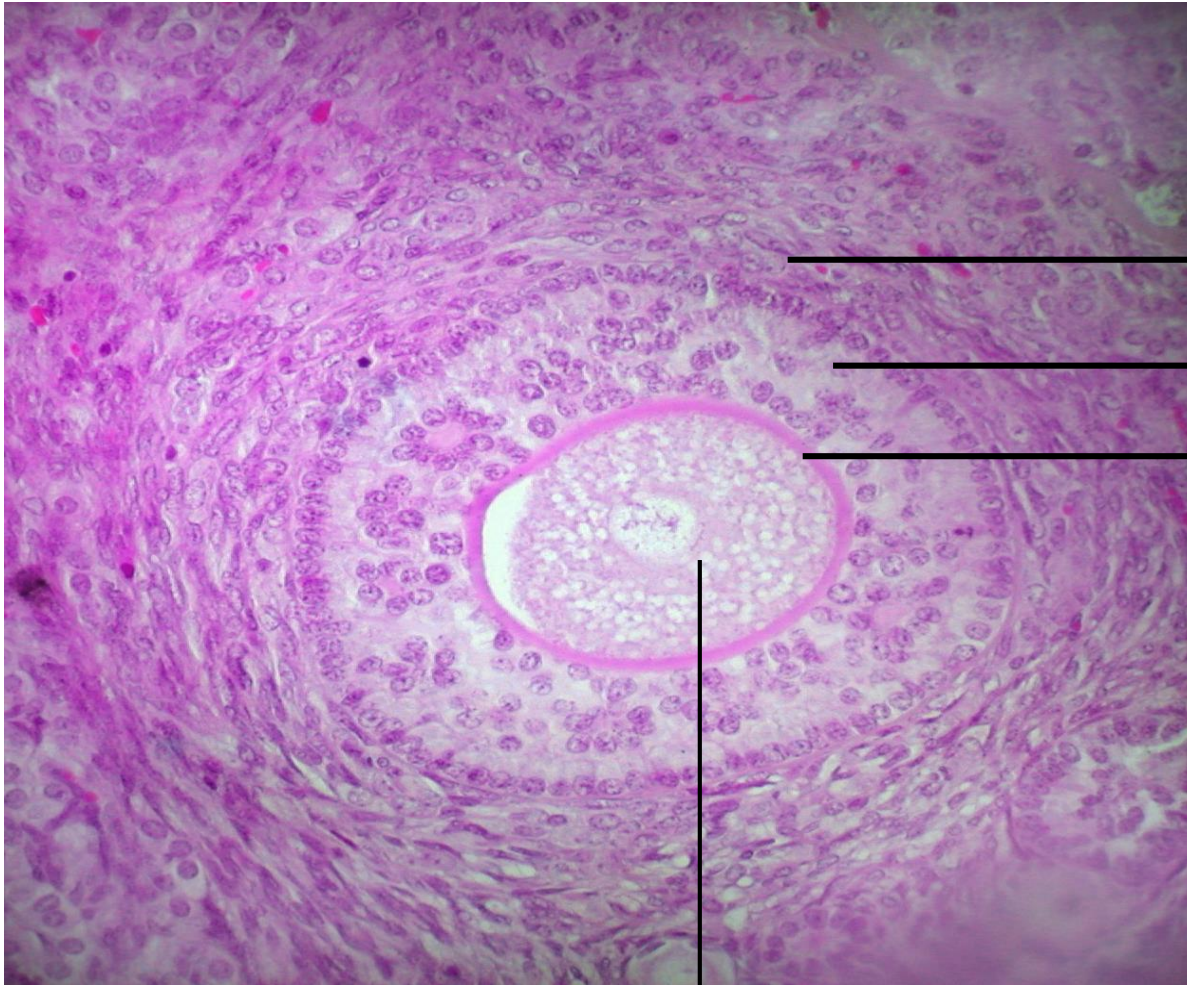




# Primary follicles



# Multilaminar primary follicle



Theca cells

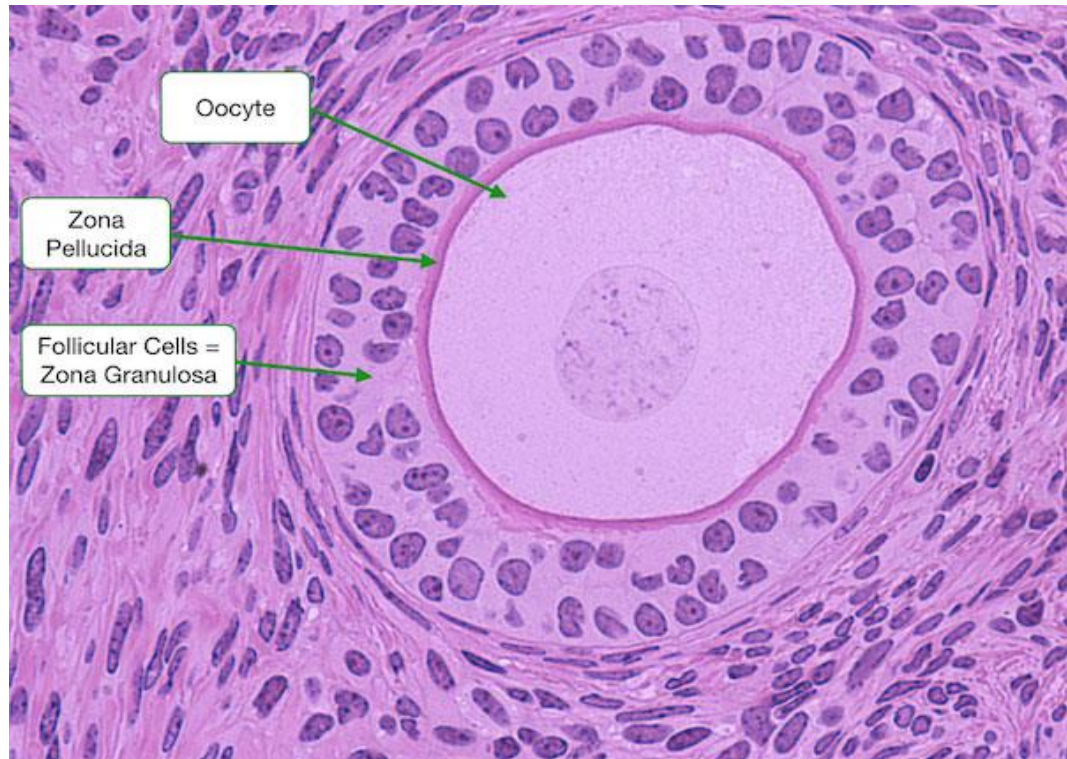
Zona granulosa

Zona pellucida

oocyte

# Zona pellucida

- **ZP-1, ZP-2, ZP-3, ZP-4** glycoproteins participate in induction of **acrosomal reaction** and in **blocking polyspermia**
- **ZP-3** is also a receptor that **recognizes and binds** the membrane proteins of the sperm

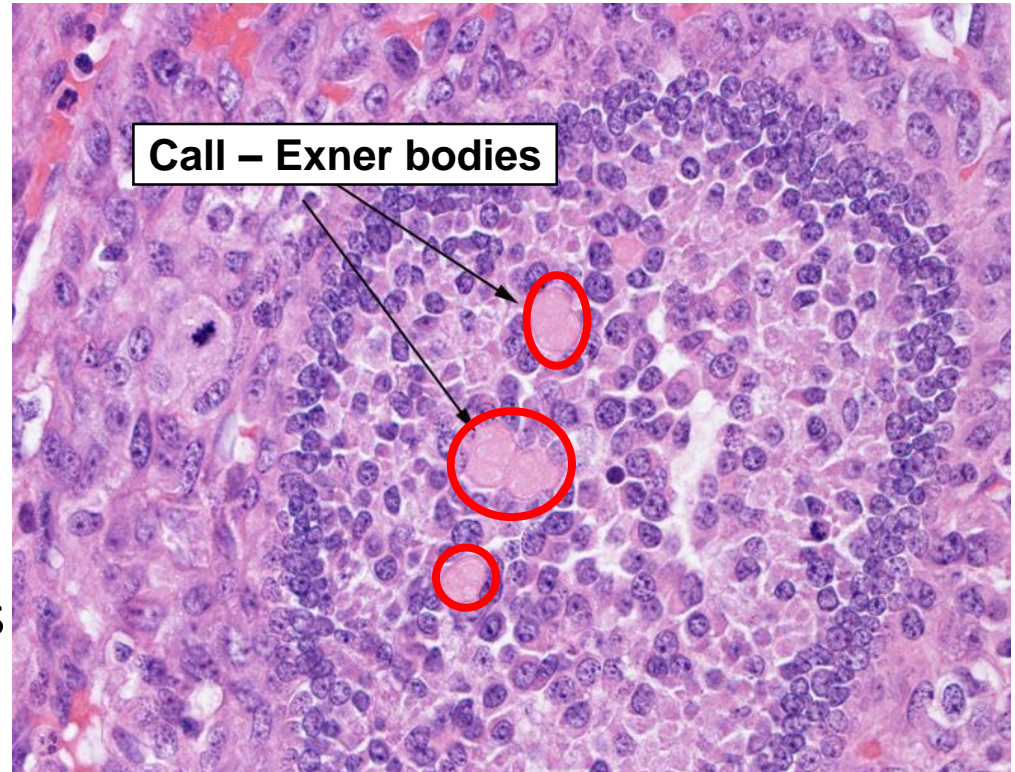


Antral follicle → secondary follicle

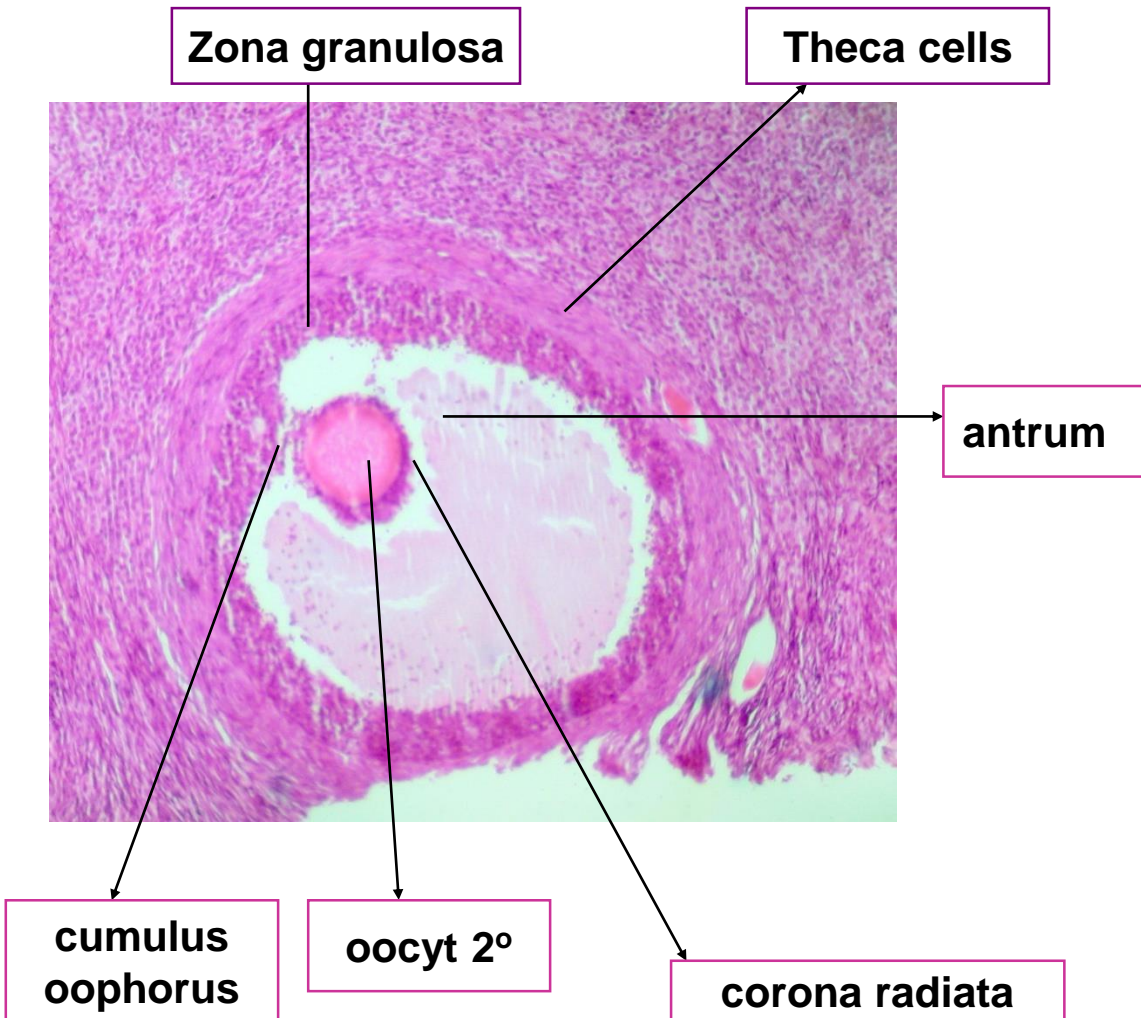


# Call - Exner bodies

- small fluid-filled spaces between granulosa cells in ovarian follicles ,
- they are composed of membrane-packaged secretion of granulosa cells and have relations to the formation of liquor folliculi which are seen among closely arranged granulosa cells.



# Graafian follicle → mature follicle

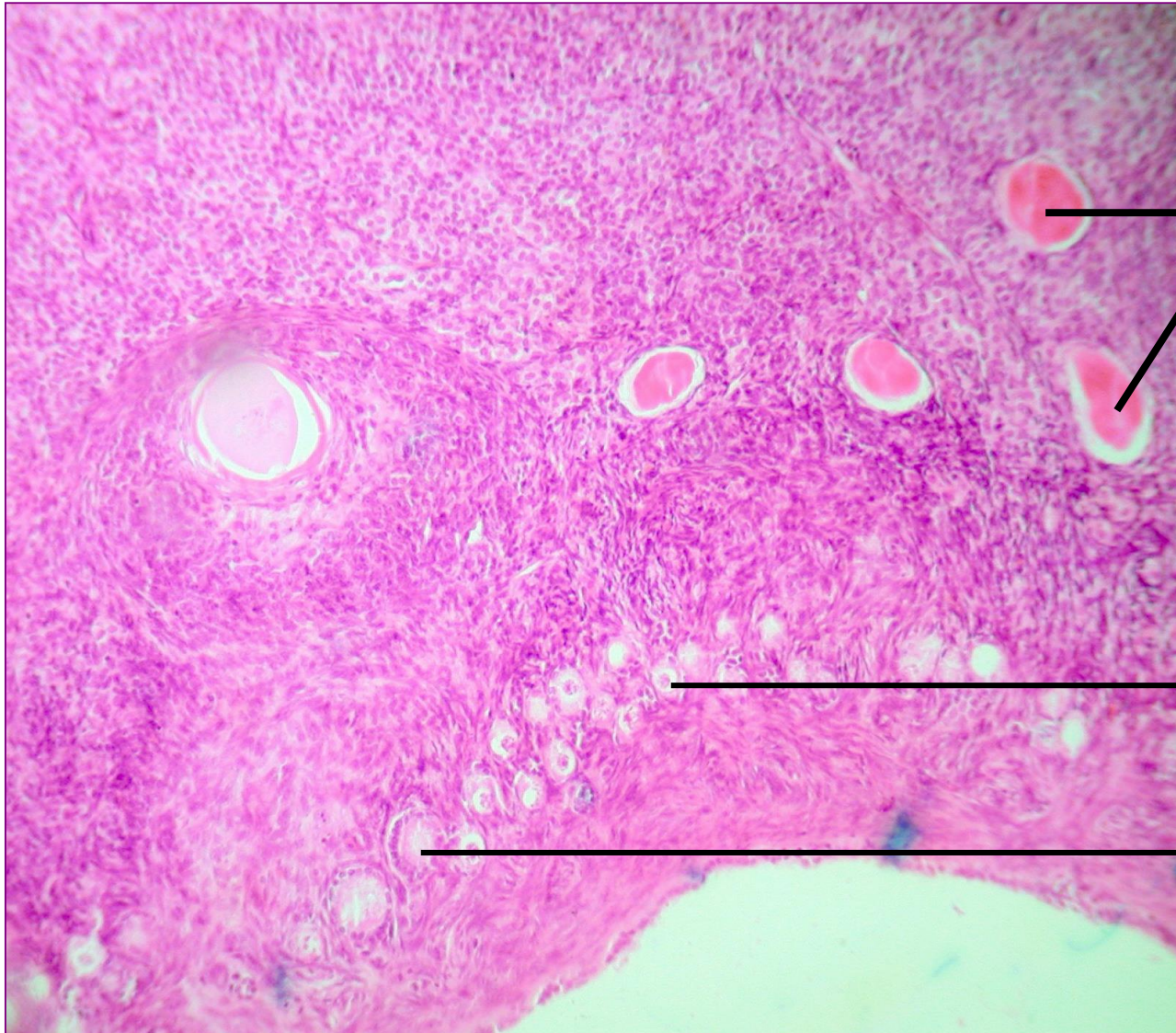


- In this follicle, the oocyte is surrounded by the **zona pellucida** and a group of cells known as the **corona radiata**, which is derived from the **cumulus oophorus**. The follicle has a large fluid-filled **antrum** and is enveloped by follicular cells comprising the **zona granulosa**, as well as **internal and external theca cells**.

# Follicular Atresia

- Most ovarian follicles undergo the degenerative process called **atresia**, in which follicular cells and oocytes die and are disposed of by phagocytic cells.
- Follicles at any stage of development, including nearly mature follicles, may become atretic.
- Atresia involves apoptosis and detachment of the granulosa cells, autolysis of the oocyte and collapse of the zona pellucida.
- in spite of the fact that follicular atresia takes place from before birth until a few years after menopause, it is most prominent just after birth, when levels of maternal hormones decline rapidly, and during both puberty and pregnancy, when qualitative and quantitative hormonal changes occur again.

# Atretic follicles



**Atretic follicles**

**Primordial follicle**

**Primary follicle**

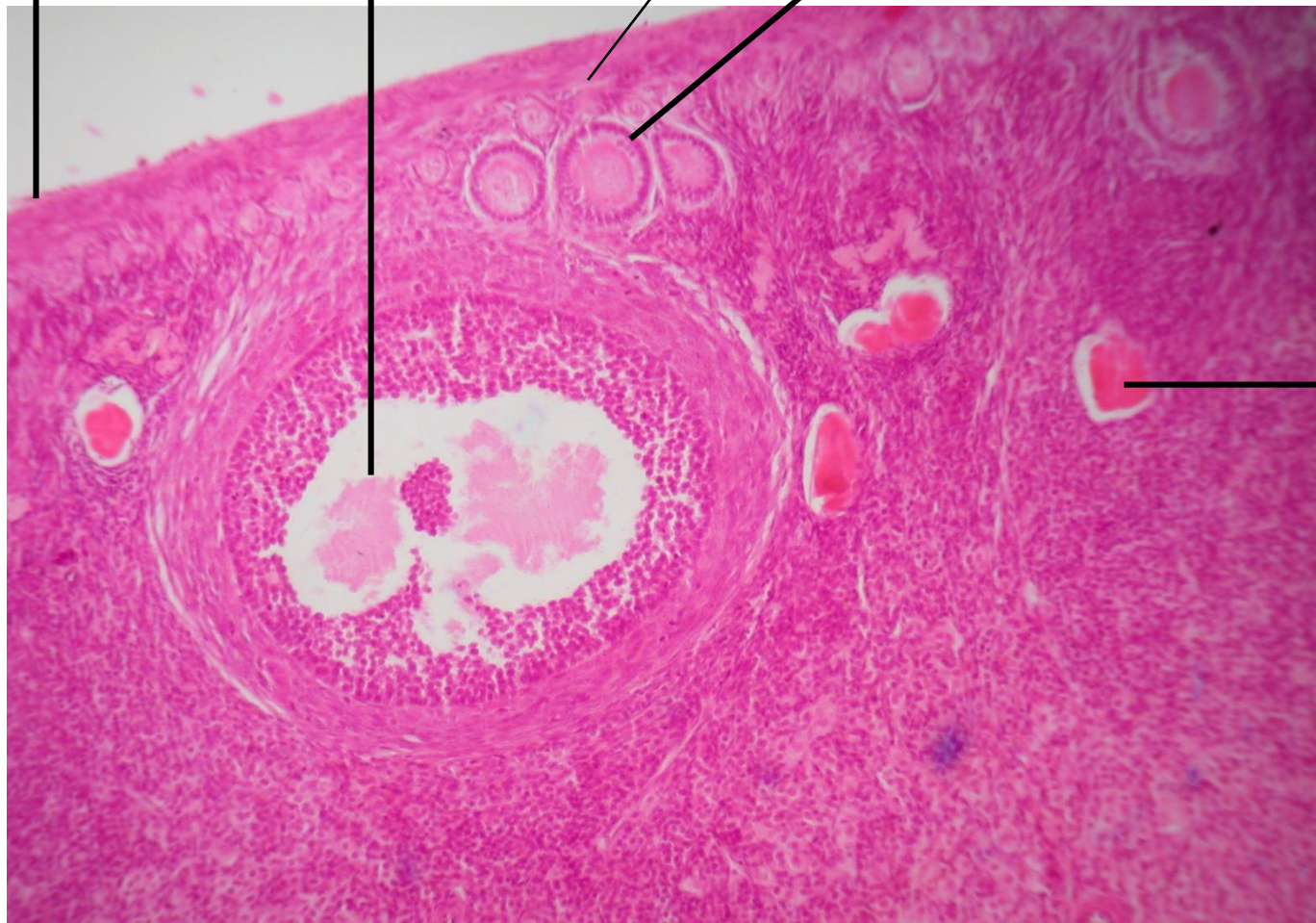


**simple cuboidal epithelium**

**tunica albuginea**

**antral follicle**

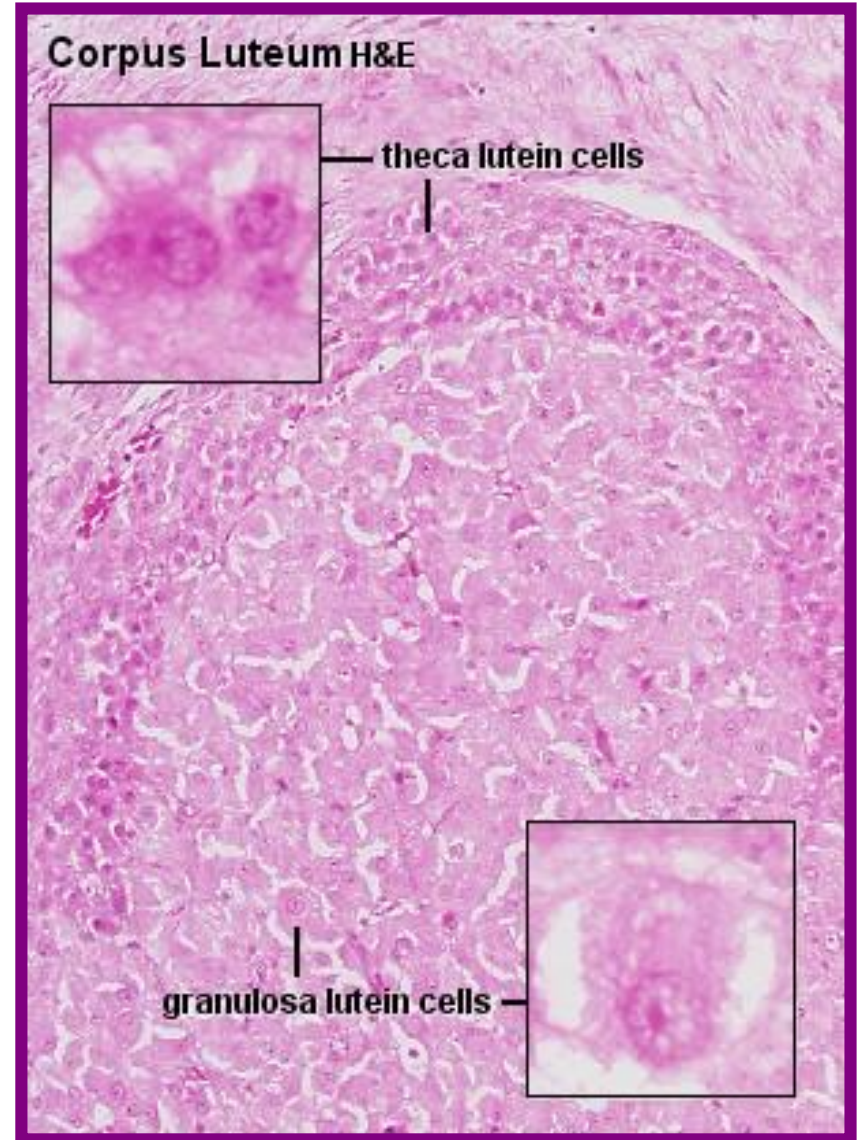
**primary follicle**



**atretic follicle**

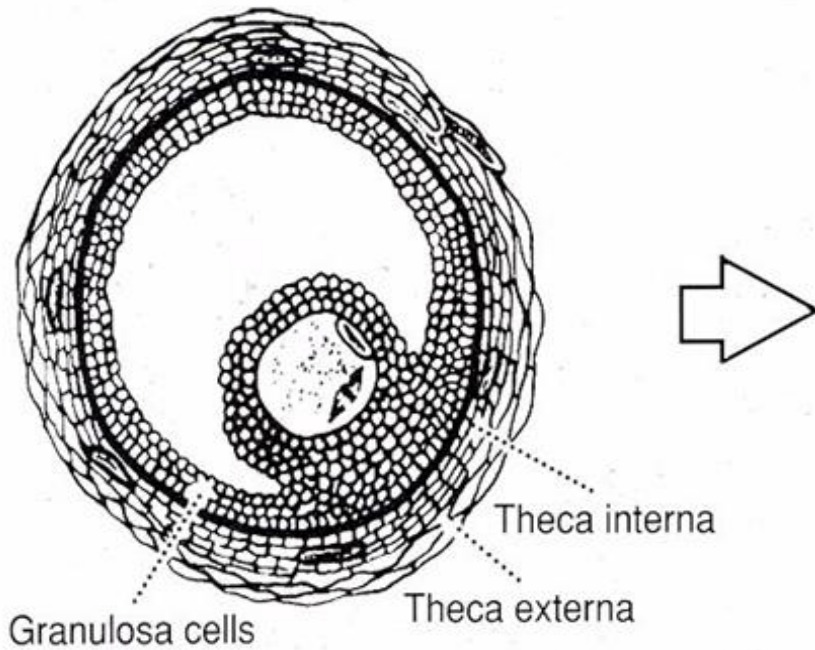
# Corpus luteum

- After **ovulation**, the portion of the follicle remaining in the ovary collapses and fills with blood, and its component cells undergo changes to form the **corpus luteum** .
- **granulosa cells** develop into **granulosa lutein cells**
- **theca cells** develop into **theca lutein cells**,
- the corpus luteum begins secreting primarily **progesterone** and to a lesser extent **estrogen**, both of which are necessary to maintain the uterine lining to prepare for implantation.

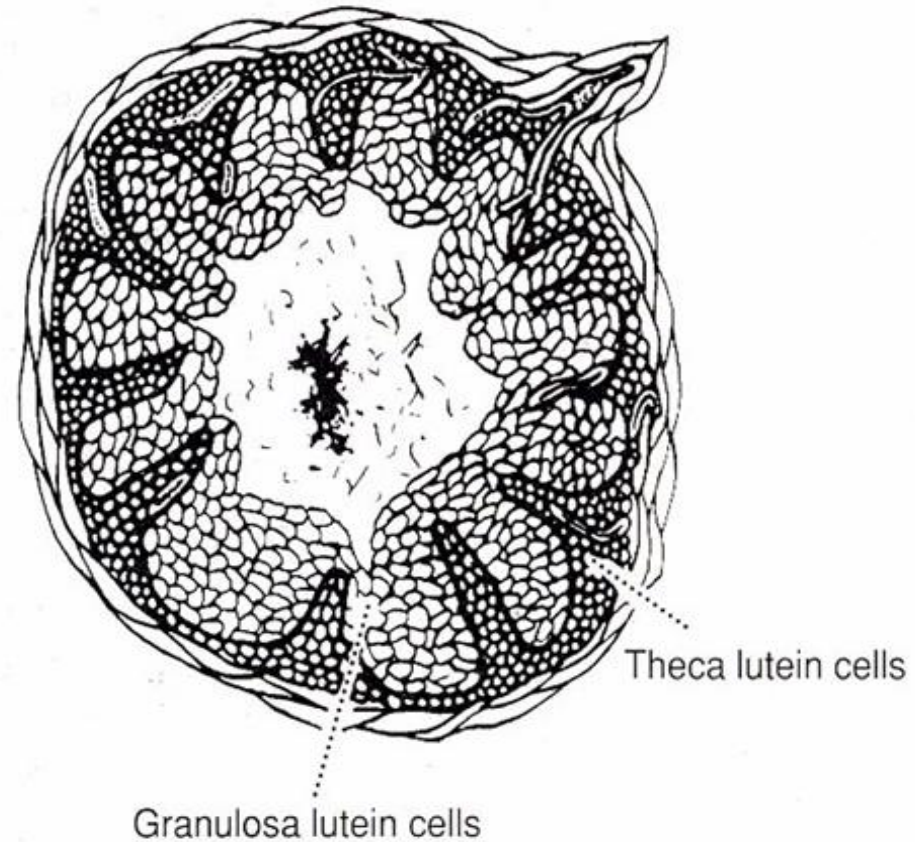


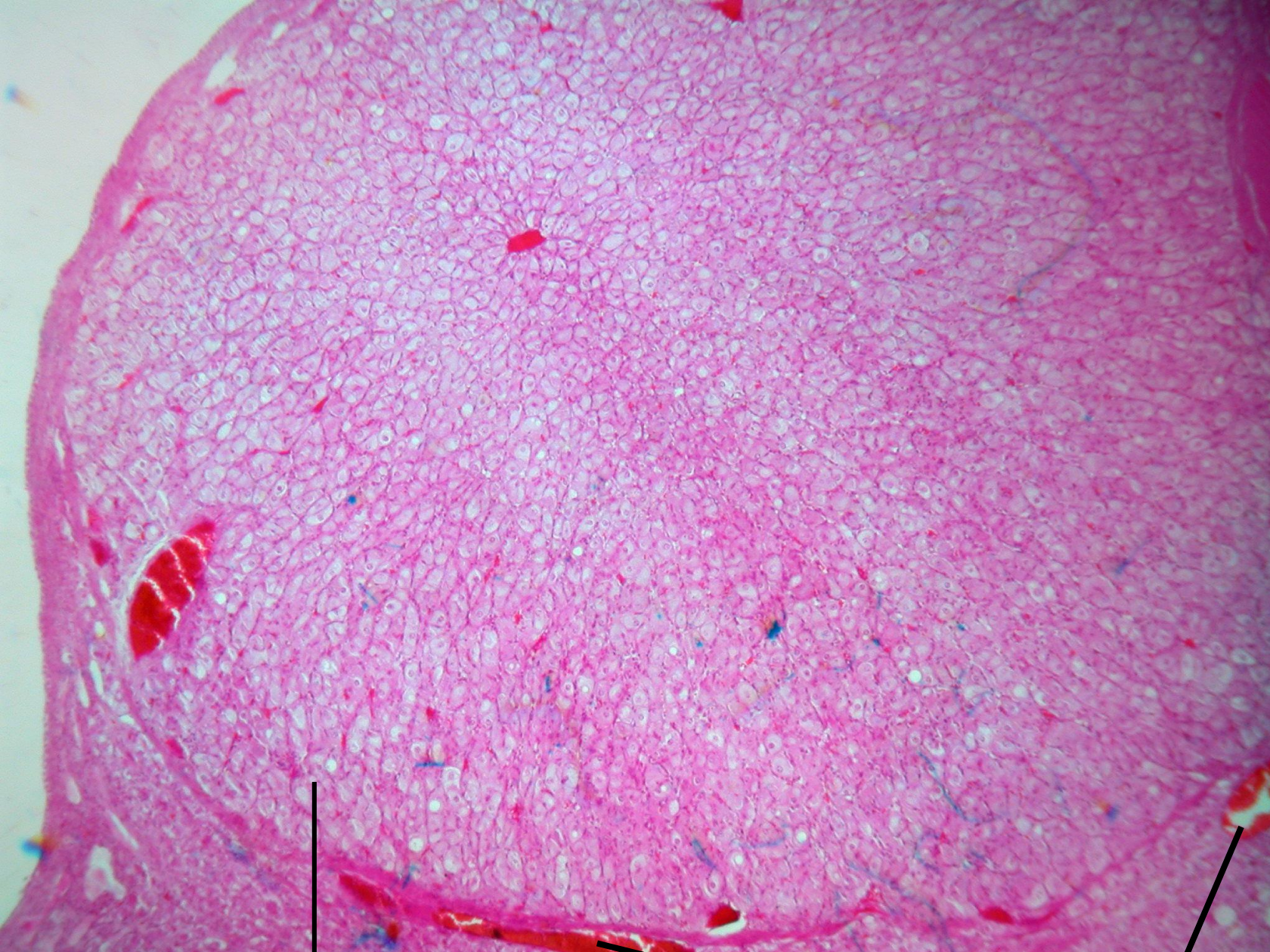
# Graafian follicle → corpus luteum

Preovulatory



Mature corpus luteum



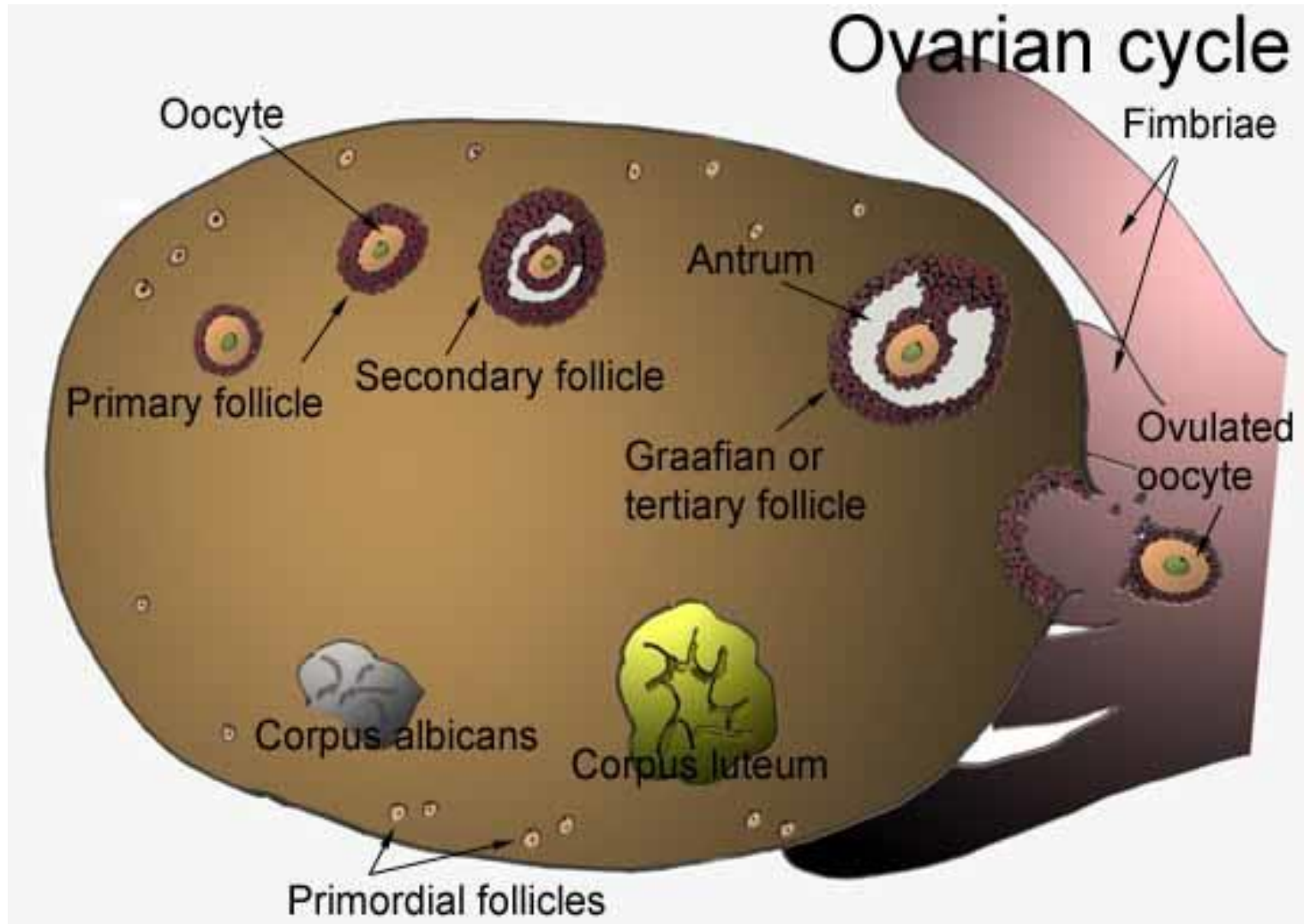


granulosa lutein cells

blood vessels



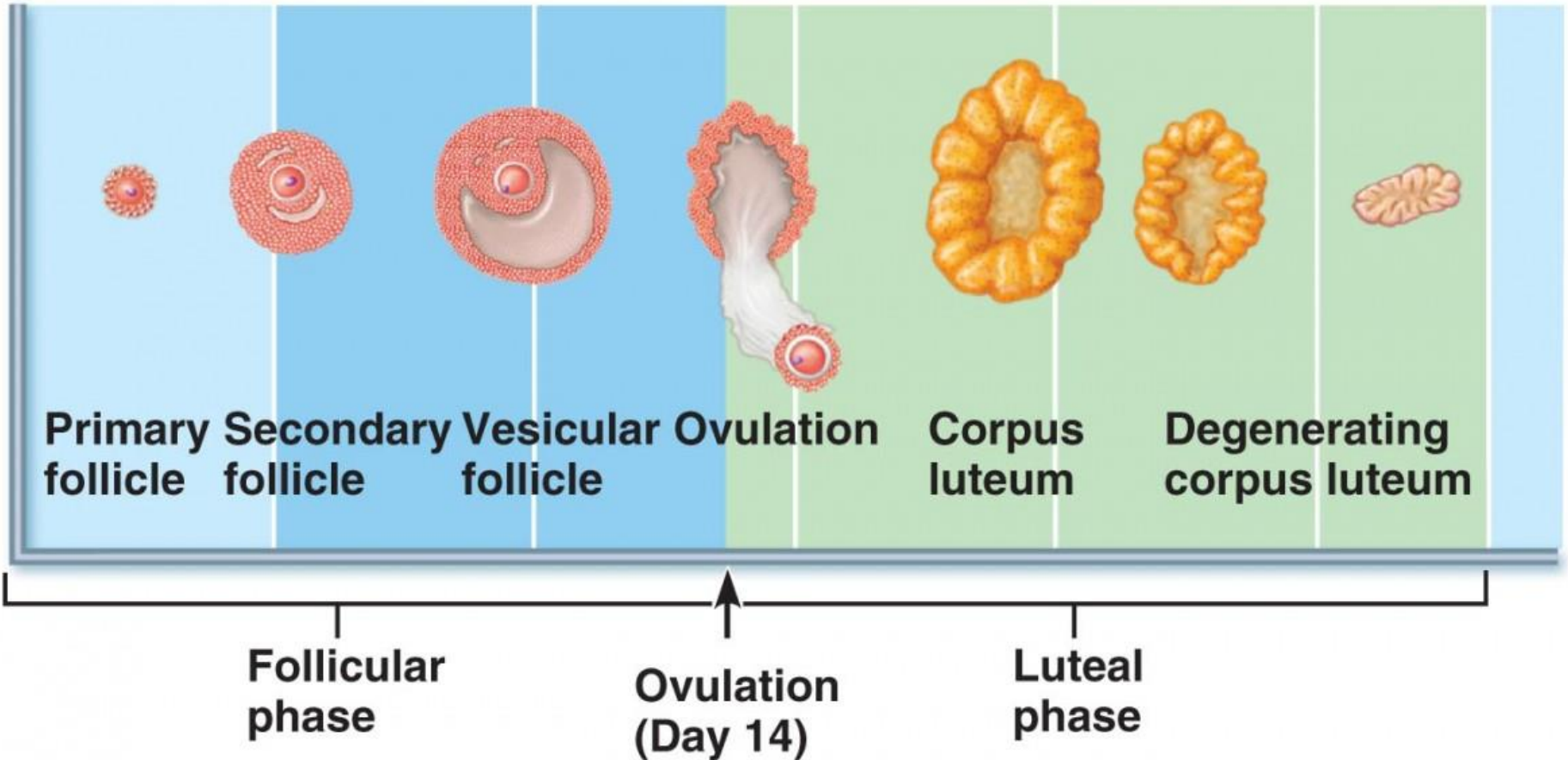
# Ovarian cycle



# Ovarian cycle

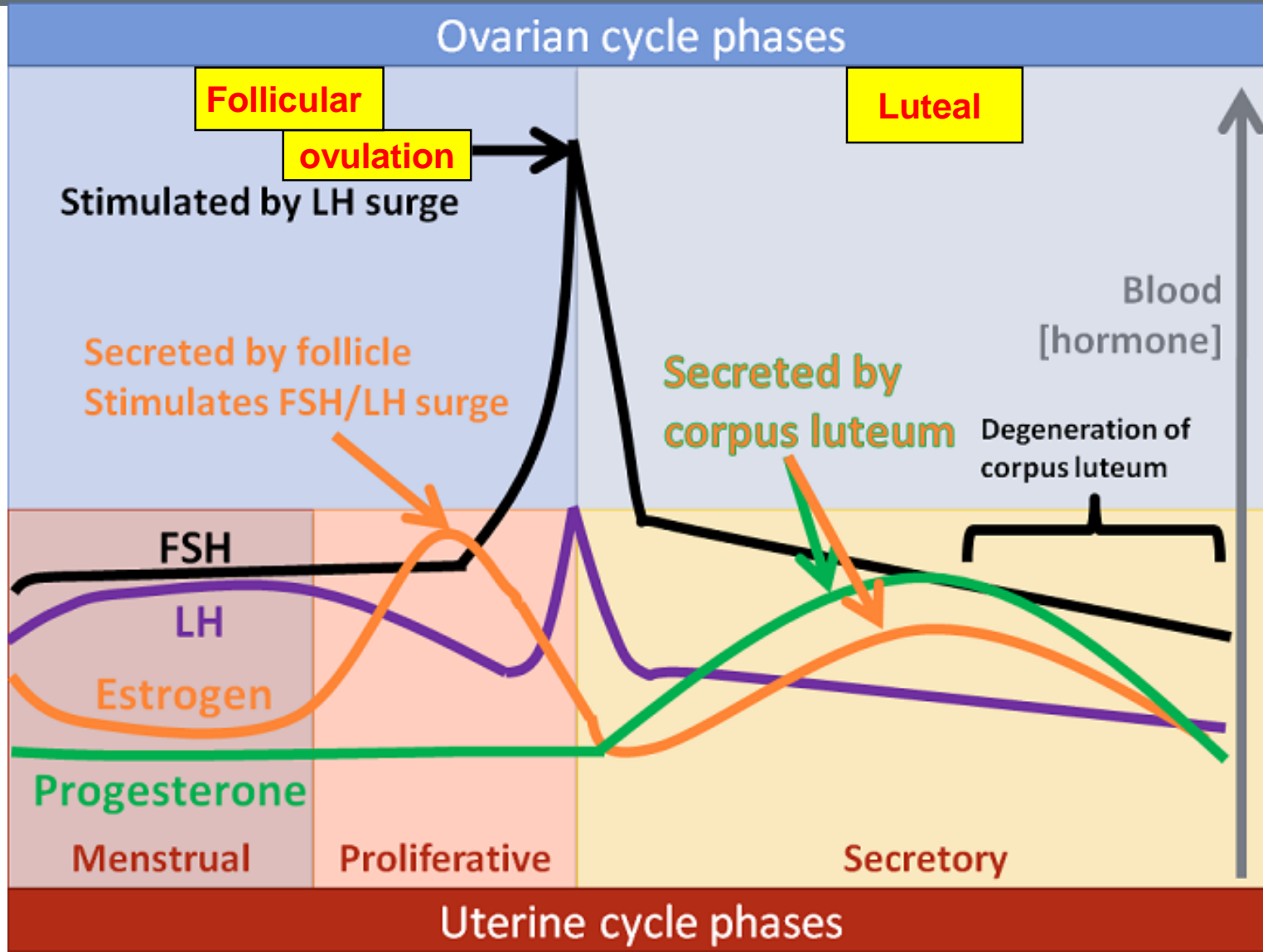
- average ovarian cycle lasts 28 days
- normally interrupted only by pregnancy
- finally terminated by menopause ovarian cycle consists of two alternating phases
  1. **Follicular phase** ( 1-14 days ) → dominated presence of maturing follicles
  2. **Luteal phase** ( 15 – 28 days ) → characterized by presence of corpus luteum

# Ovarian cycle



**Ovarian cycle:** Structural changes in the ovarian follicles during the ovarian cycle

# Ovarian cycle (1)

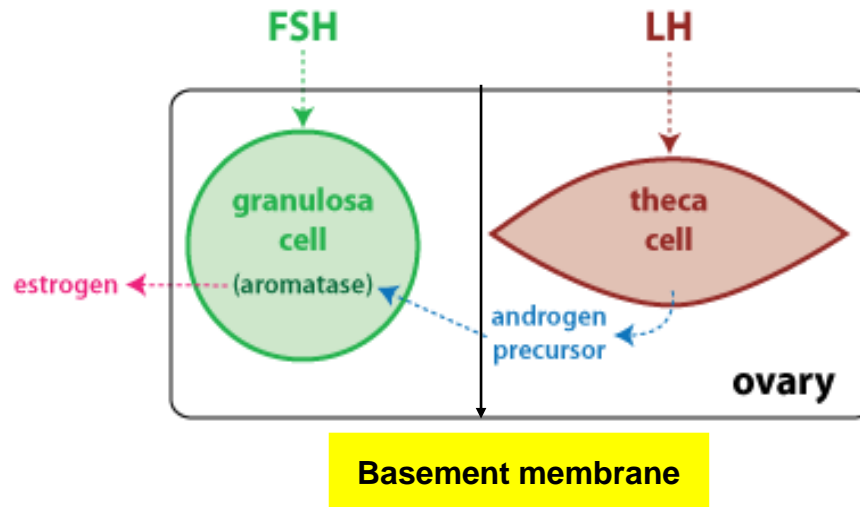




# Follicular phase

- The first part of the hormonally-regulated cycle is called the **follicular phase** ( **growth phase**).
- during the follicular phase, a cohort of follicles that have undergone initial development are stimulated to develop further by rising concentrations of gonadotropins,
- **follicle stimulating hormone (FSH)** and **luteinizing hormone (LH)**.
- if a follicle undergoes initial development, but does not receive hormonal support for further development, it will undergo a process of degeneration that is known as **atresia**. Atresia is the fate for all but a few hundred follicles in the ovary.

# Follicular phase



- as the follicles grow in response to stimulation from the **gonadotropins**, they also start to secrete increasing amounts of **estrogen**.
- the two cell types collaborate in the production of estrogen !!!
- theca cells produce the **androgen precursor** (under the influence of LH), which is then converted to estrogen (specifically, estradiol) by the granulosa cells
- **granulosa cells** express the enzyme **aromatase** (under the influence of FSH), which converts an **androgen precursor** to estrogen,

# Ovulation

- In the late follicular phase, the level of **estrogen** secretion from the dominant follicle crosses a certain threshold, and the feedback effect of estrogen now switches to *positive feedback*.
- This means that estrogen now **stimulates LH secretion**, which in turn stimulates more estrogen production by the follicle. The result is a rapid rise in LH secretion, the **LH surge**.
- The LH surge triggers the rupture of the dominant follicle, in other words, **ovulation**.
- The first division of meiosis occurs just prior to ovulation (the second division occurs after the egg is penetrated by the sperm).

# Luteal phase

- After ovulation, **LH** stimulates the formation of the **corpus luteum**.
- The corpus luteum secretes high levels of **both estrogen and progesterone !**
- The combination of high **estrogen** together with **progesterone** causes **negative feedback inhibition** of gonadotropin secretion, thus preventing maturation and ovulation of other follicles.
- The corpus luteum persists as long as LH levels stay above a certain level. Once LH secretion falls below a certain level, the corpus luteum degenerates.
- The drop in estrogen and progesterone secretion releases the hypothalamus and pituitary from negative feedback inhibition, allowing FSH and LH levels to steadily increase. This starts a new cycle.



# Oogenesis

**Definition :** formation of primary oocytes  
from oogonium

**Duration:** is completed before birth

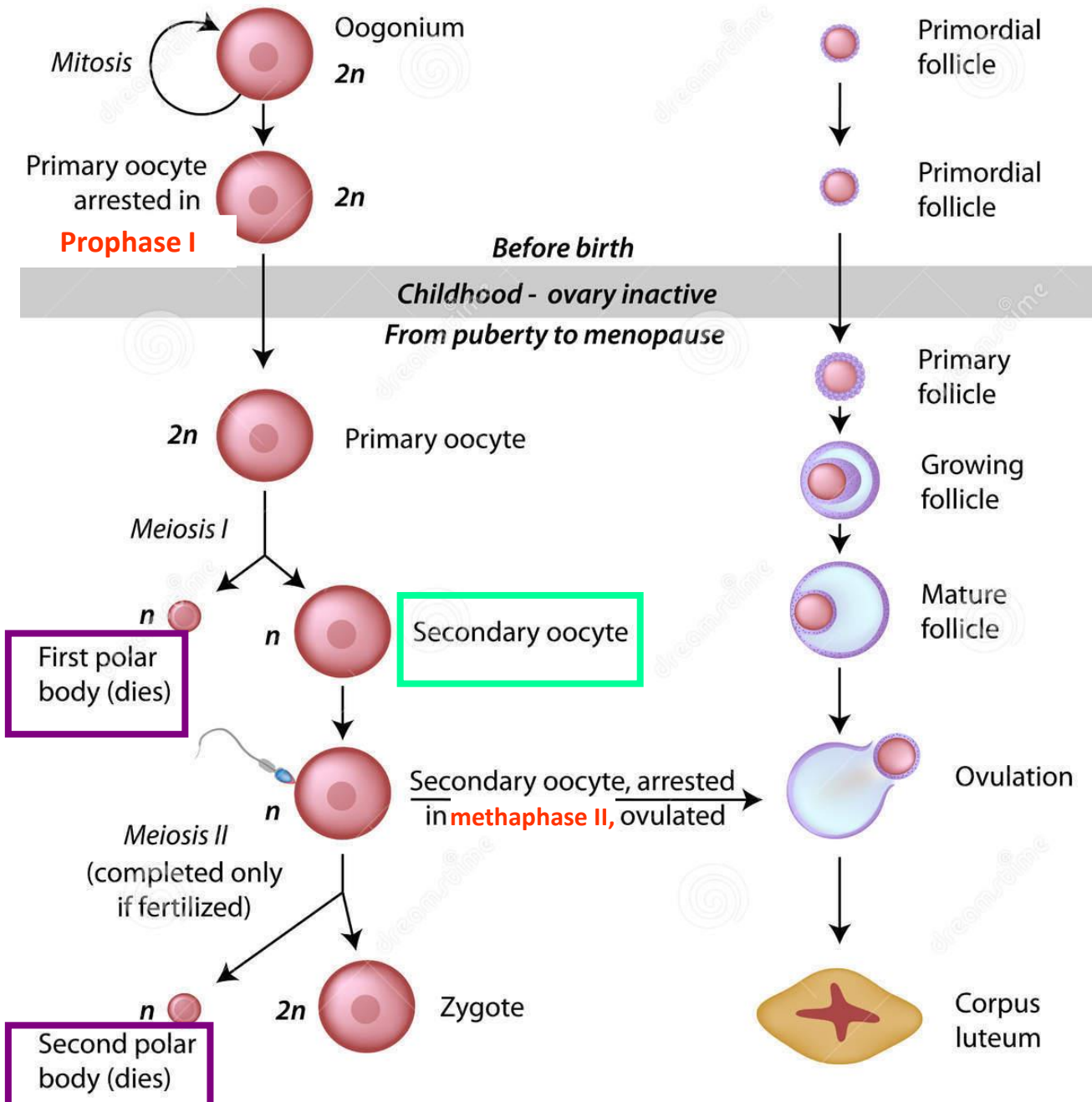
**Count:** 6-7 million oogonia by the fifth month  
of gestation

**Sequence:** after birth the number is reduced  
to 2 million

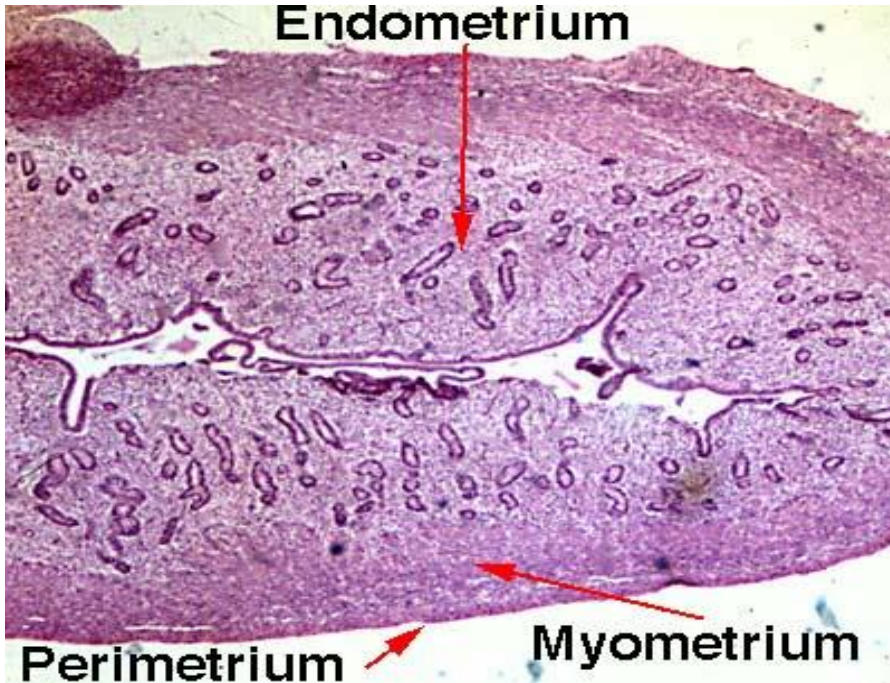
- at puberty – 300,000 oogonia present
- during reproductive age only 400 – 500 ova mature and ovulate

# Oogenesis

# Follicle development



# The Uterus



The uterus is composed of three important layers:

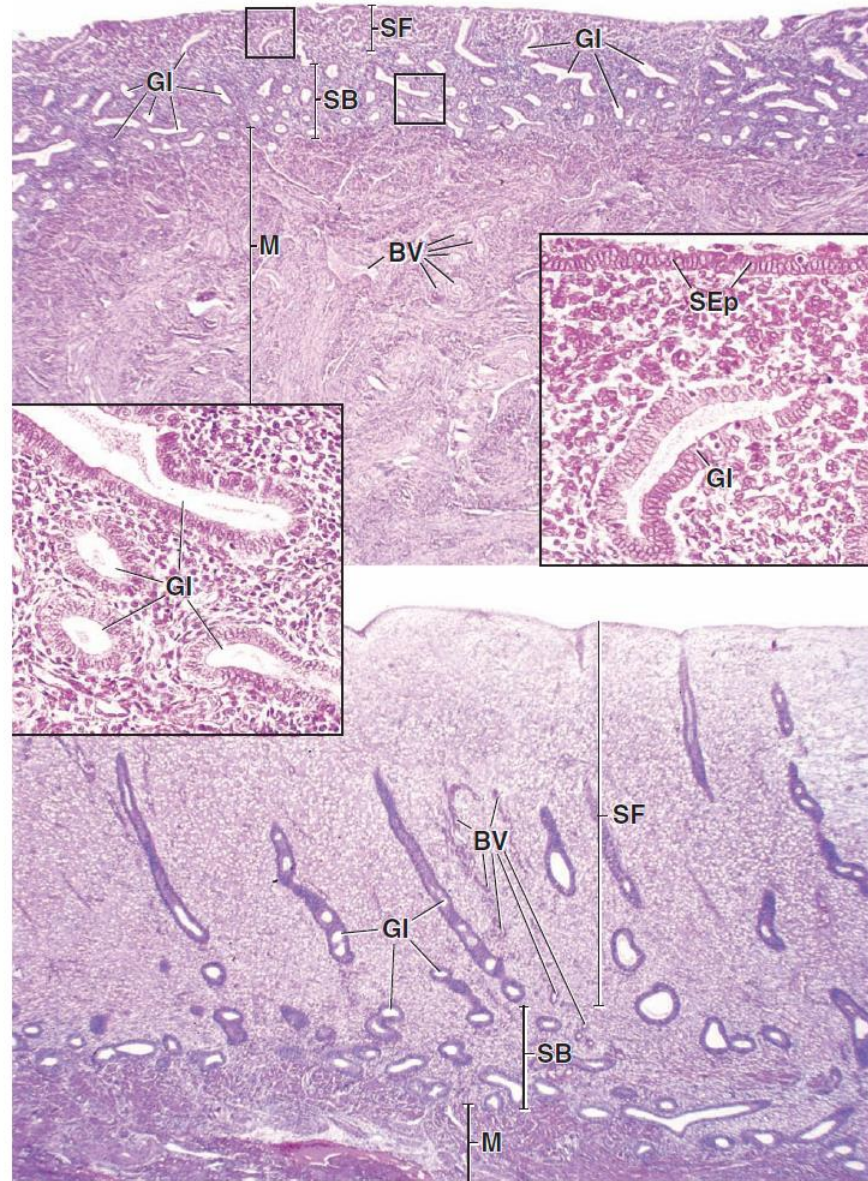
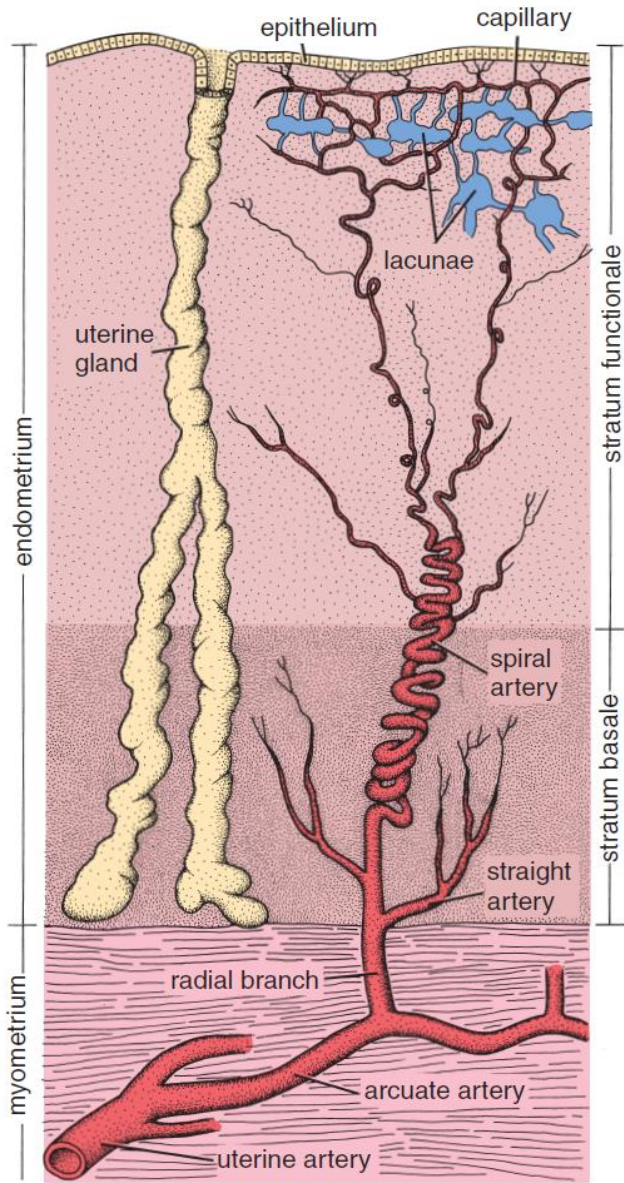
- endometrium
- myometrium
- perimetrium

# Histology of the uterus

- The mucosa of the uterus is known as the **endometrium**.
- It is a **columnar epithelium** that contains numerous **tubular glands**.
- some of the epithelial cells are **ciliated** while the rest contain **microvilli**.
- It has two component sub-layers:
  1. **the stratum functionalis** , which changes over the course of the cycle,
  2. and the **stratum basalis** , which remains relatively constant.

The endometrium is highly vascularized, with a blood supply consisting of straight arteries that form a plexus in the stratum basalis and **spiral arteries** that extend to the surface of the stratum functionalis.



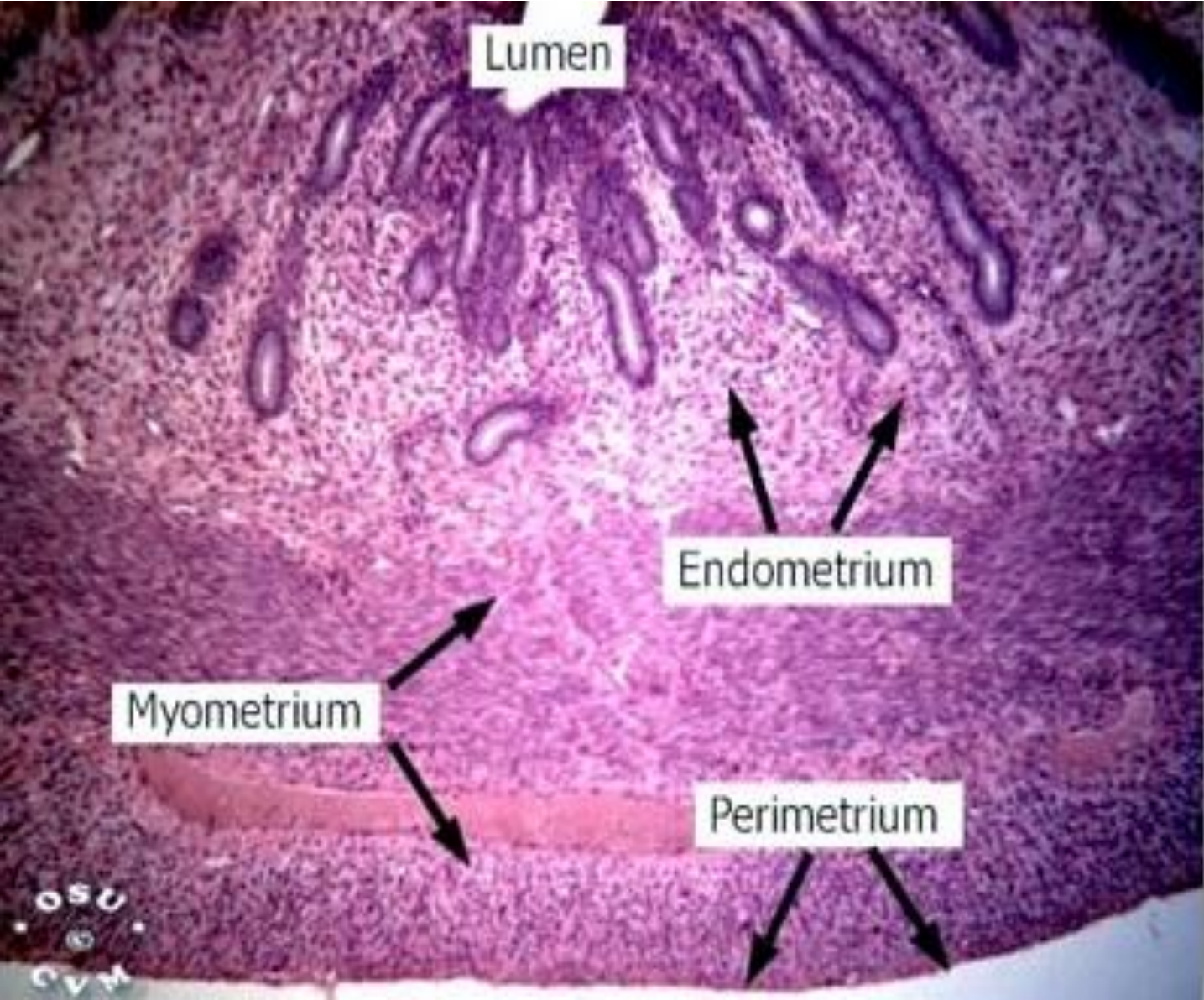


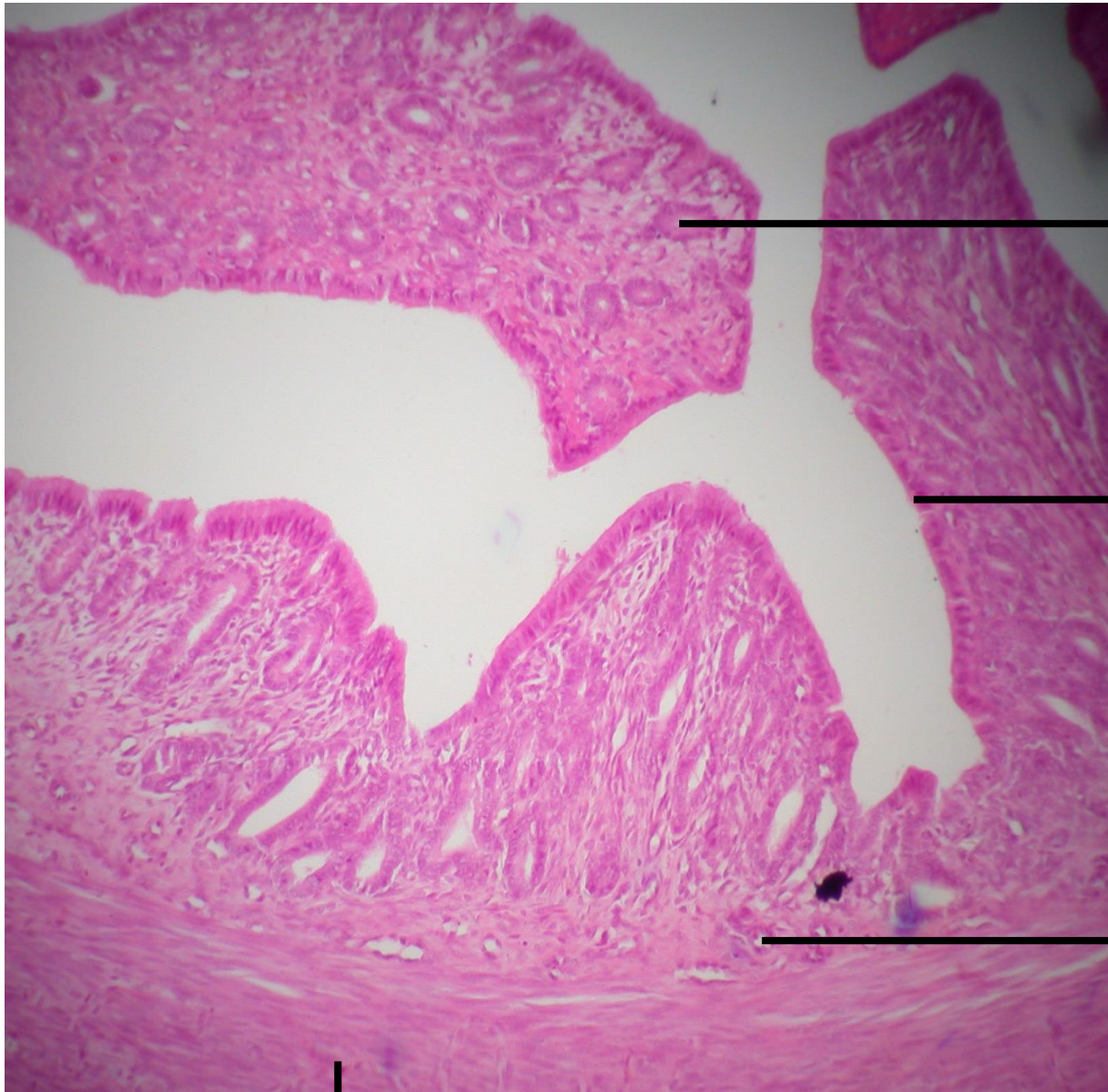
GI – endometrial (uterine) glands  
BV – blood vessels

SF – stratum functionale  
SB – stratum basale  
M - myometrium

# The Uterus

- the **muscularis layer** of the uterus is the **myometrium**
- it is a thick smooth muscle layer that expands during pregnancy and serves to protect and expel the fetus. The middle layer of the myometrium, the stratum vasculare , contains many large blood vessels
- the **serosal layer** of the uterus is the **perimetrium**
- it is composed primarily of connective tissue.





**uterine gland**

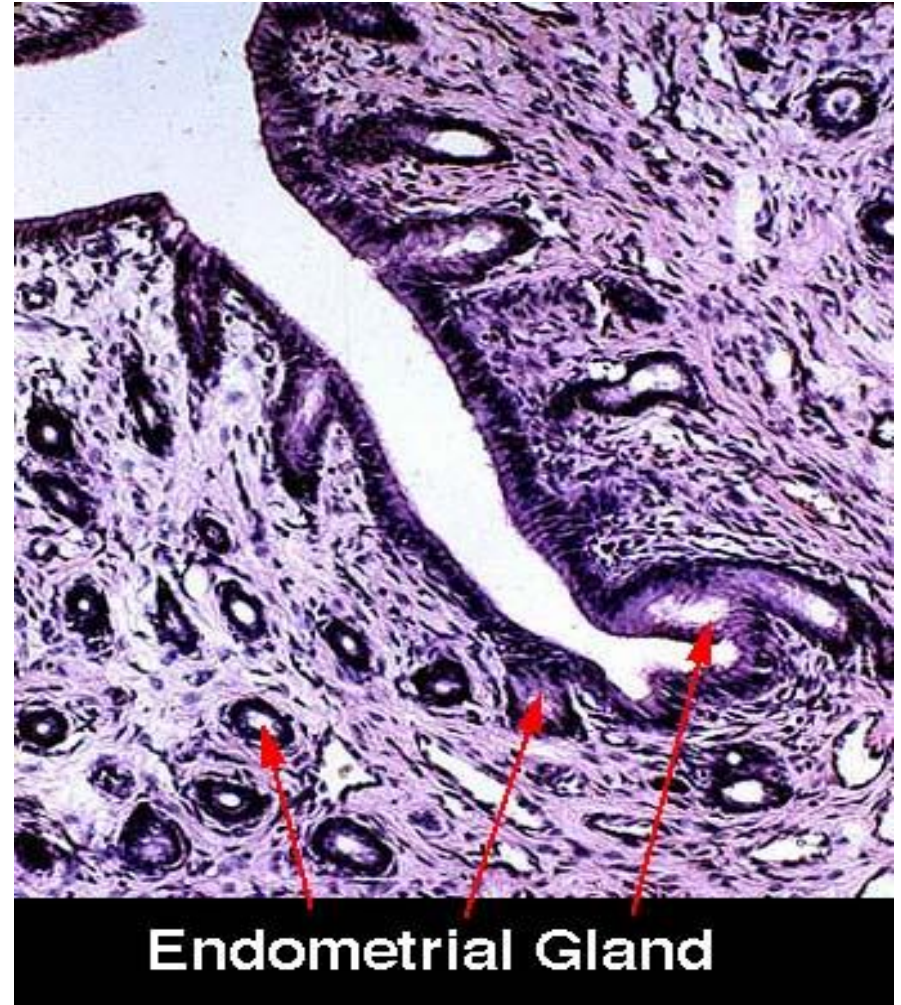
**simple columnar epithelium**

**artery**

**myometrium**

# Uterine glands

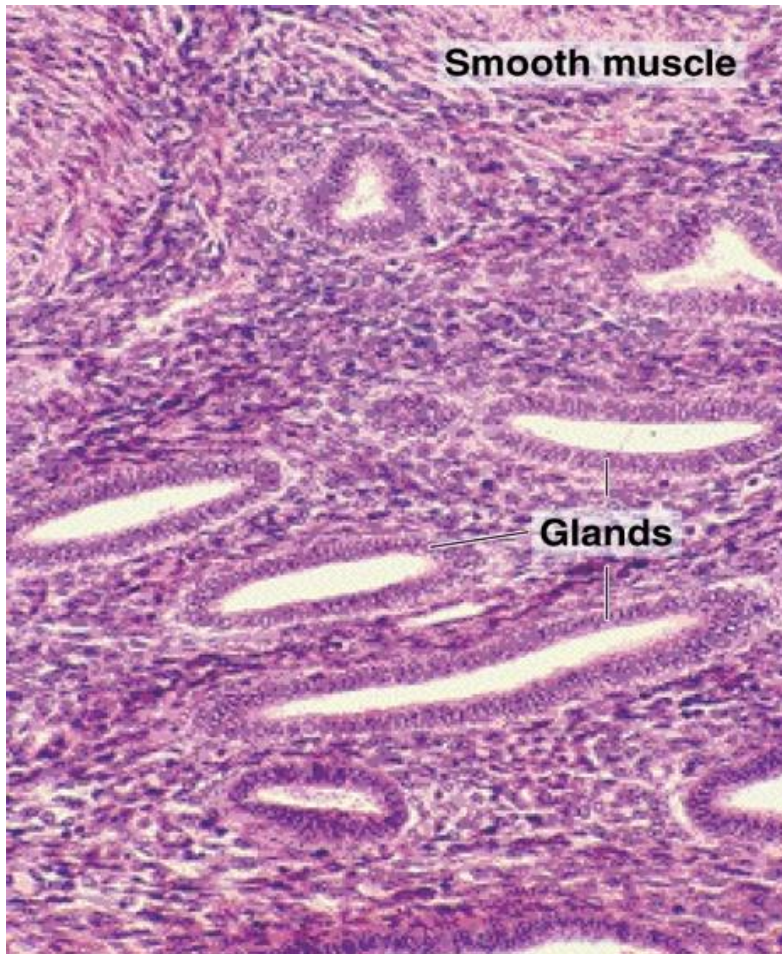
- simple, tubular glands
- lined by simple columnar epithelium
- they secrete a mucus substance that creates an optimal environment for the sperm



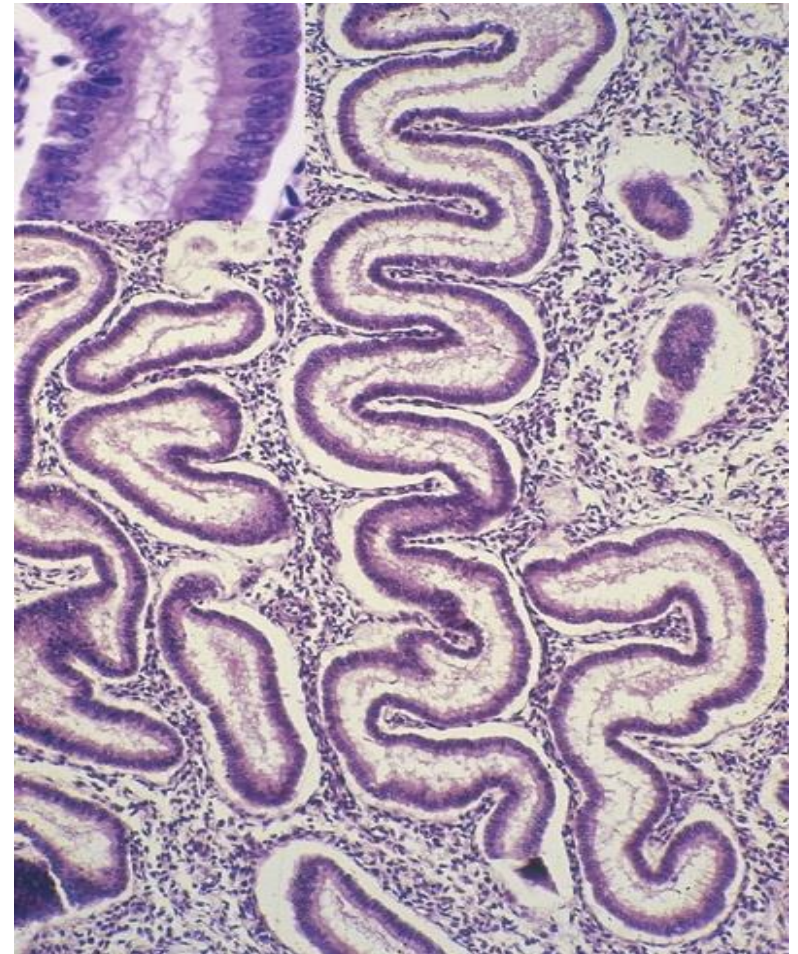
# Uterine glands

proliferative phase

secretory phase



The glands are simple, narrow and do not contain secretions



The glands are wide, twisted, longer with secretions in the middle

# The Uterine Cycle

## (1)

- The **proliferative phase** begins on the first day of the menstrual flow and is maintained by the production of estrogen by the developing follicles.
- In this phase, the endometrium is densely populated by fibroblasts and the uterine glands are small (10 micron) invaginations.
- From the day 8 to 14, the uterine glands elongate as the entire endometrium doubles or triples in thickness.
- The final endometrial thickness may be as much as five millimeters.
- During the late stages of this phase, blood vessels from the stratum vasculare invade the endometrium.

# The Uterine Cycle (2)

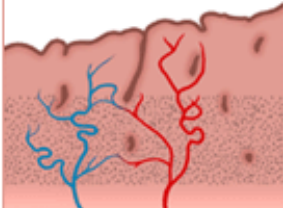
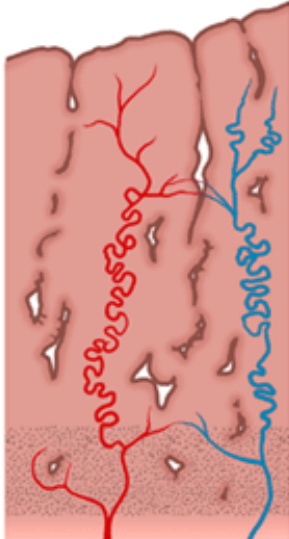
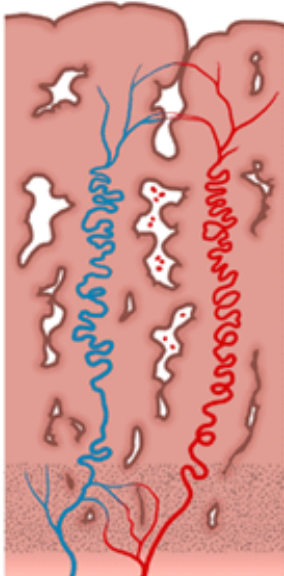
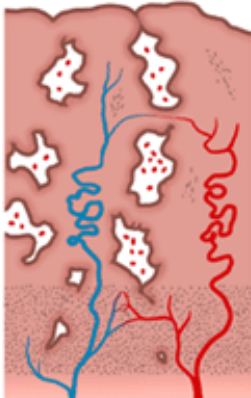
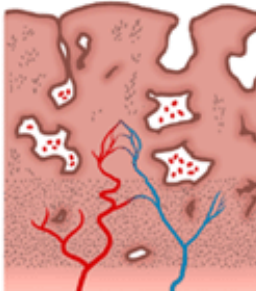
- The **secretory phase** begins at ovulation and is governed by **progesterone** and **estrogens** production from the corpus luteum.
- The glands become closely packed, coiled, and dilated ( 50 microns).
- The columnar epithelium discharges a carbohydrate-rich secretion that nourishes the ovum.
- **Coiled arteries** extend toward the epithelium and anastamose to enhance the blood supply of the endometrium.

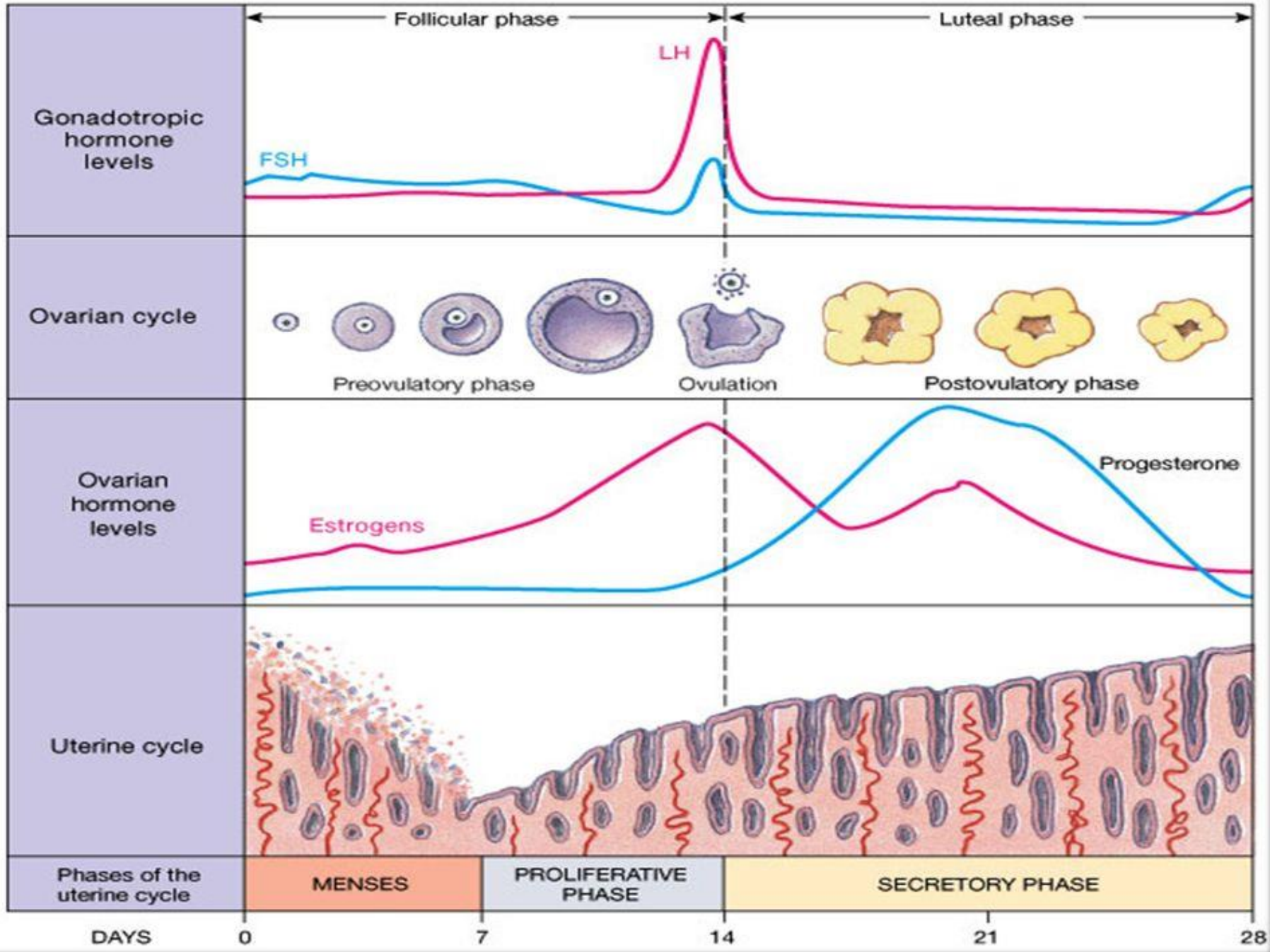


# endometrial changes in **menstrual cycle**

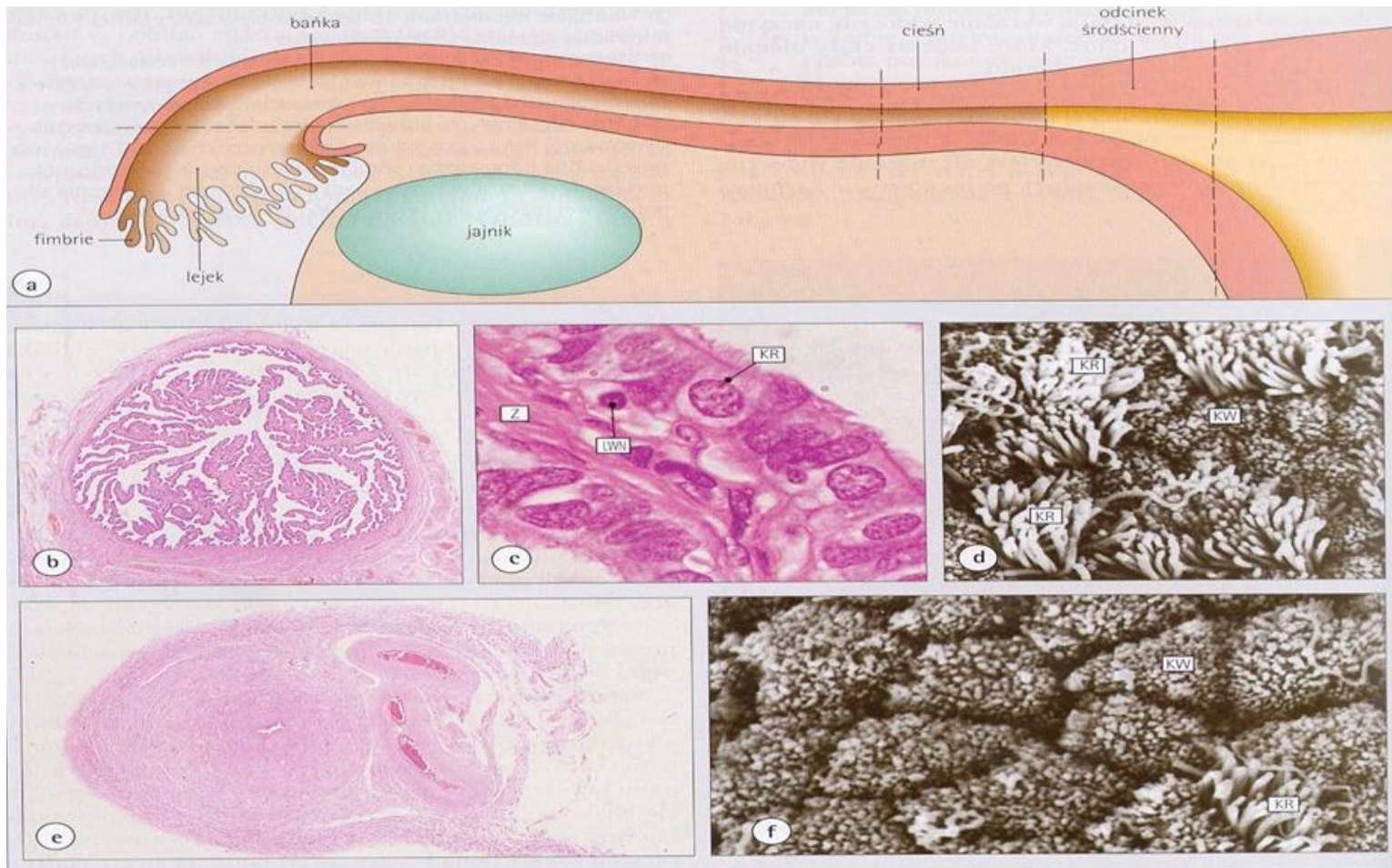
## Cyclic Changes in the Endometrium

MM<sup>4</sup>

DAY 4	DAY 14	DAY 20	DAY 25	DAYS 28-4
<b>Early Follicular Phase</b>	<b>End of Follicular Phase, Beginning of Luteal Phase</b>	<b>Luteal Phase</b>	<b>End of Luteal Phase; Premenstrual</b>	<b>Menstrual Phase</b>
<i>(at end of menstruation)</i>	<i>(at the time of ovulation)</i>	<i>(mid-secretory)</i>	<i>(late-secretory)</i>	<i>(menstrual)</i>
<p>A lot of mitotic activity in glands which elongate in stroma which swells in vessels which grow. Cells in glands do not show signs of secretory activity</p>	<p>Less mitoses but glandular epithelial cells show signs of secretory activity.</p>	<p>Glands coiled. Lumina distended with fluid. Stromal cells become voluminous. A lot of dermal fluid in the superficial zone.</p>	<p>Reabsorption of edema fluid leads to collapse of superficial zone. Blood "lakes" due to breakage of capillaries. Coiled arteries constrict periodically, leading to blanching of mucosa, ischemia.</p>	<p>Superficial zone breaks down. Stroma, blood lakes, superficial part of glands, vessels, are sloughed away down to the basal zone. The basal zone is preserved.</p>
				



# Oviduct



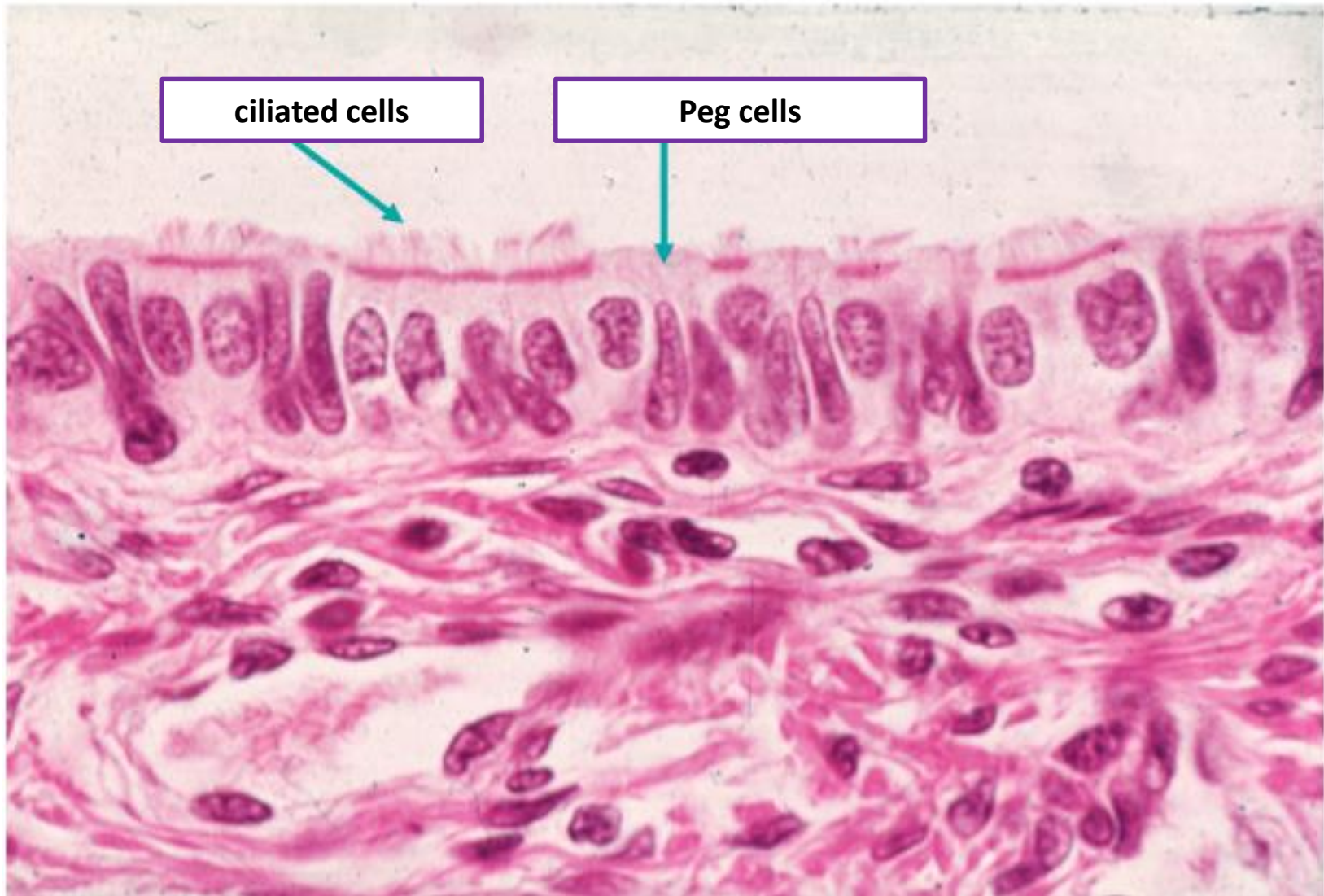
# The oviducts or fallopian tubes

- The oviducts or fallopian tubes transport the ovum from the ovary to the uterus and serve as the site of fertilization.
- They have a muscular wall with a folded mucosa composed of a **ciliated columnar epithelium**. There are three types of epithelial cell:
  1. **Peg cells** - which are not ciliated . These cells are secretory .These cells secrete nutrient material for the ovum. The peg cells are particularly prominent at day 14 of the menstrual cycle - ie. around the time of ovulation.
  2. **Ciliated cells** - the apical surface is ciliated, and some cells have large accumulations of glycogen.

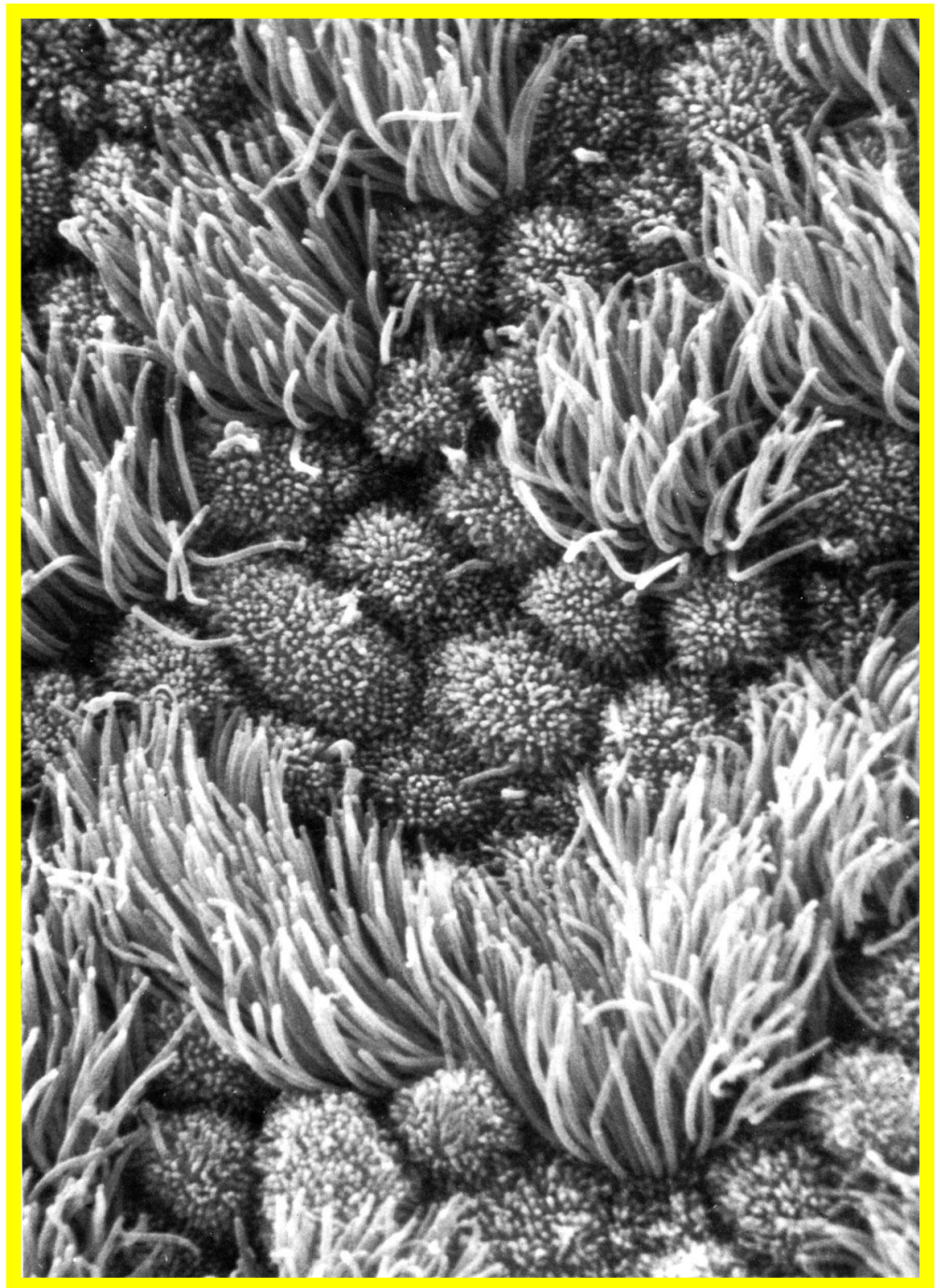
The cilia help to move the fluid away from the ovary towards the uterus, thus moving the ovum towards the uterus.

1. **Intercalated cells** - may be a morphological variant of secretory cells.
- A thick epithelium and thin muscle layer characterize the former two regions; the latter two regions have more muscle and a thinner epithelium.

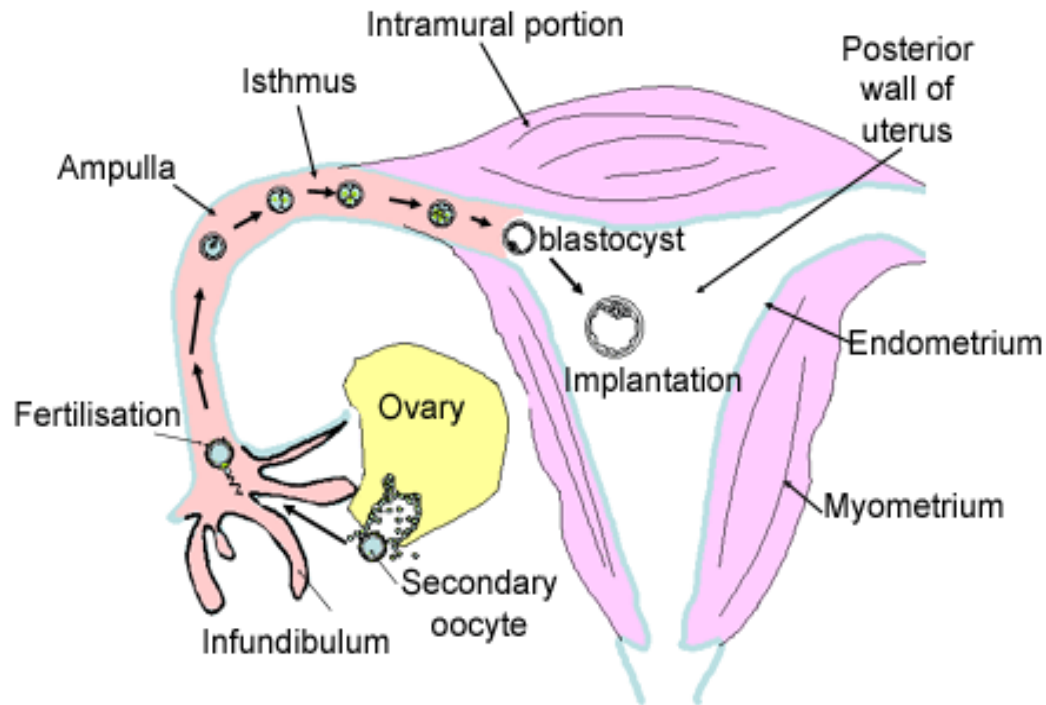
**Epithelium of oviduct**  
simple columnar epithelium



# Epithelium of oviduct



# oviduct

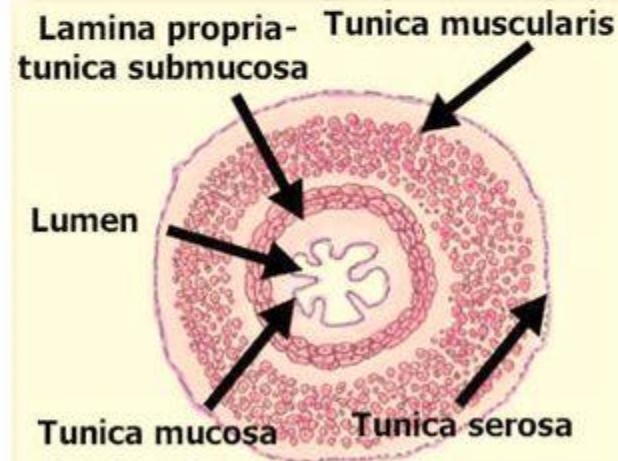
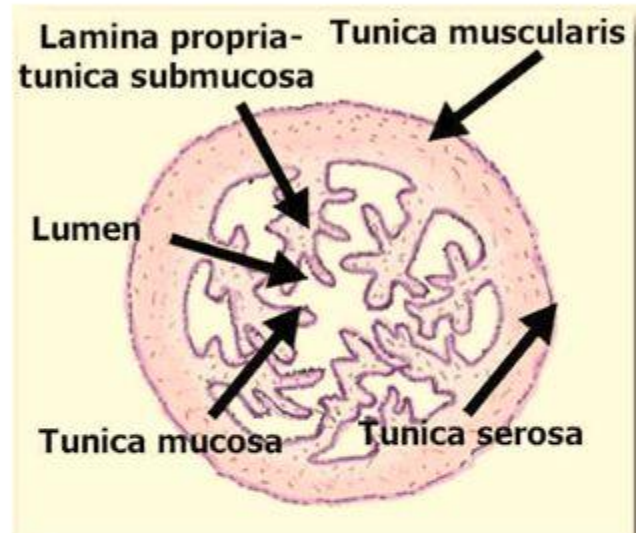


The oviducts are divided into four parts:

- the **infundibulum**,
- the **ampulla**, the longest and expanded area where fertilization normally occurs,
- the **isthmus**, a more narrow region nearer the uterus, and
- the **uterine or intramural part**, which passes through the wall of the uterus and opens into the interior of this organ.

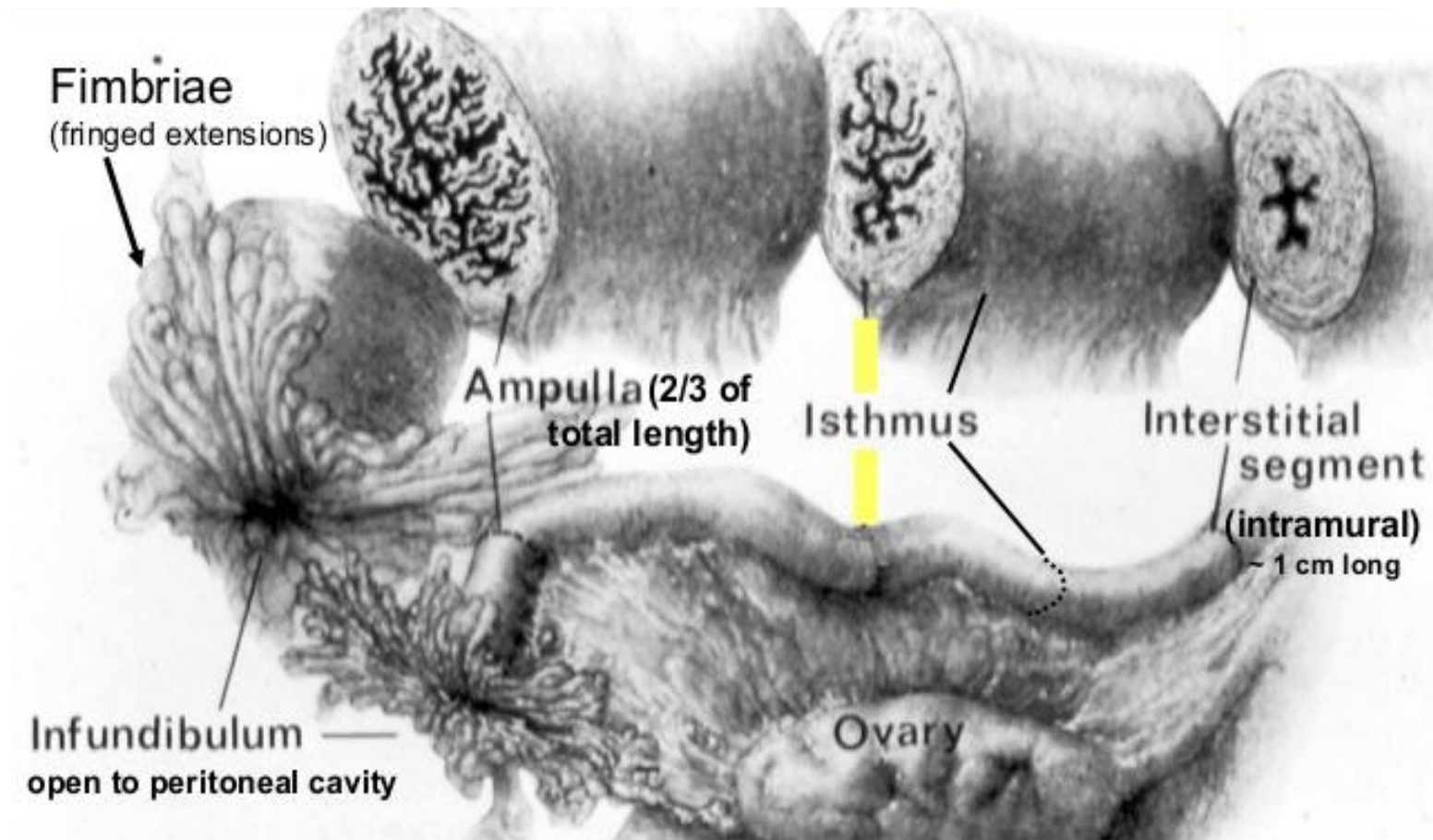
# Oviduct

- Thickness and specific characteristics of histologic layers vary with the segments
- Infundibulum and ampulla:
  - Tunica mucosa: thick, highly developed.
- Isthmus:
  - Tunica mucosa: thinner
  - Tunica muscularis: thicker





# Differences in the construction of individual parts of the fallopian tube





serosa

Muscle layer

Blood vessels

mucosa

lumen

# Netography:

- [http://download.videohelp.com/vitualis/med/his\\_ovarian\\_follice\\_pic.htm](http://download.videohelp.com/vitualis/med/his_ovarian_follice_pic.htm)
- <http://histologyatlas.wisc.edu/slides/443/labeled>
- <http://www.siumed.edu/~dking2/erg/RE006b.htm>
- [http://medcell.med.yale.edu/histology/ovary\\_follicle.php](http://medcell.med.yale.edu/histology/ovary_follicle.php)
- [https://en.wikipedia.org/wiki/Call-Exner\\_bodies](https://en.wikipedia.org/wiki/Call-Exner_bodies)
- <https://www.pinterest.com/pin/652740539711808109/>
- <https://www.lab.anhb.uwa.edu.au/mb140/CorePages/FemaleRepro/femalerepro.htm>
- [https://www.123rf.com/photo\\_97131103\\_corpus-albicans-human-ovary-the-corpus-albicans-is-the-regressed-form-of-the-corpus-luteum-after-the.html](https://www.123rf.com/photo_97131103_corpus-albicans-human-ovary-the-corpus-albicans-is-the-regressed-form-of-the-corpus-luteum-after-the.html)
- <http://humanbiologylab.pbworks.com/w/page/85966873/Organ%20Histology%20of%20Uterus>
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**Thank you for your  
attention !**

