

FEMALE REPRODUCTIVE SYSTEM

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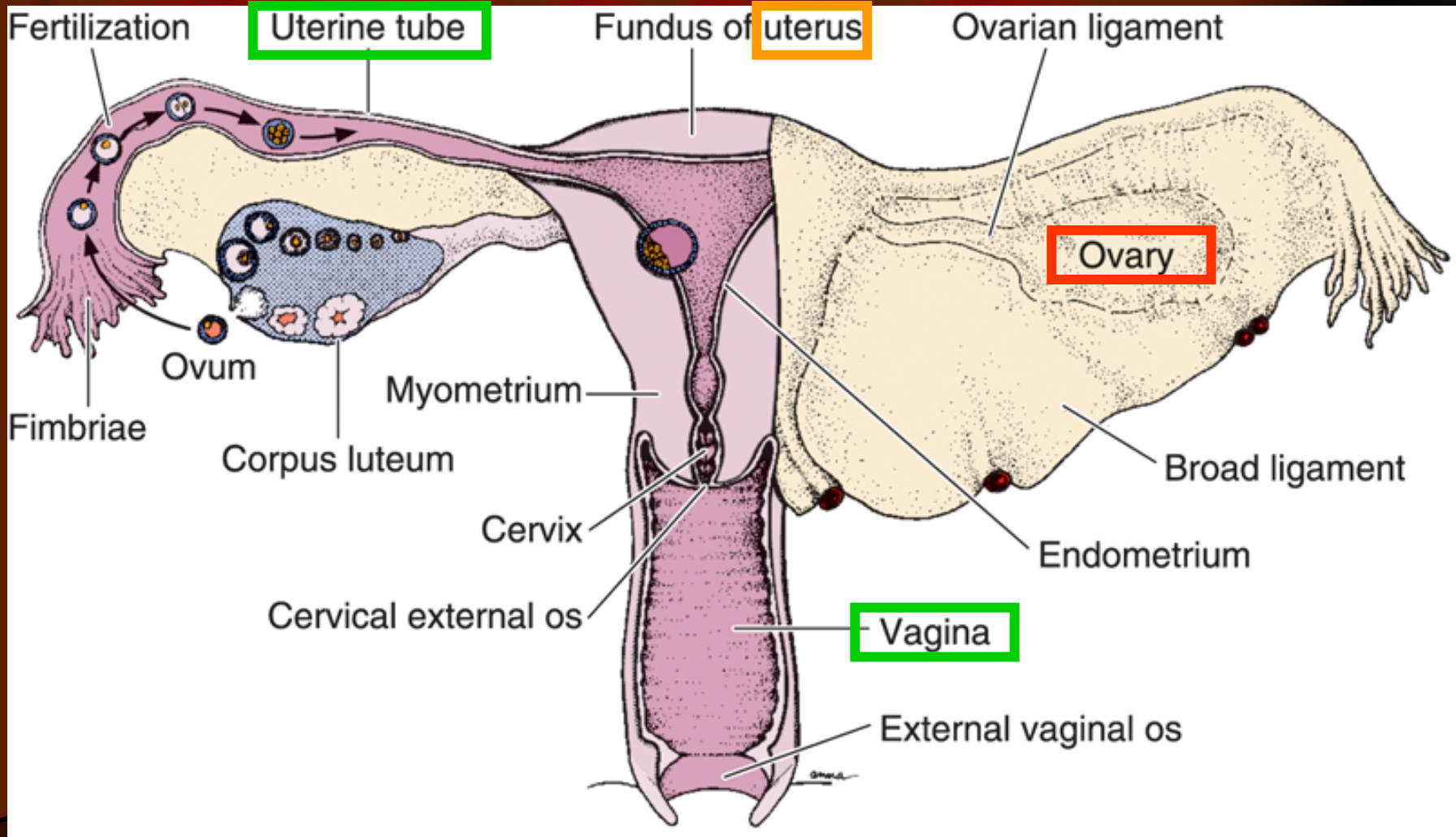
OBJECTIVES

- Overview of female reproductive system
- Structure of ovary and **maturation of oocyte**
- Structure of uterine tube, uterus and vagina
- Endometrial structure and changes, as well as its **regulation** during menstrual cycle
- Structure of mammary gland

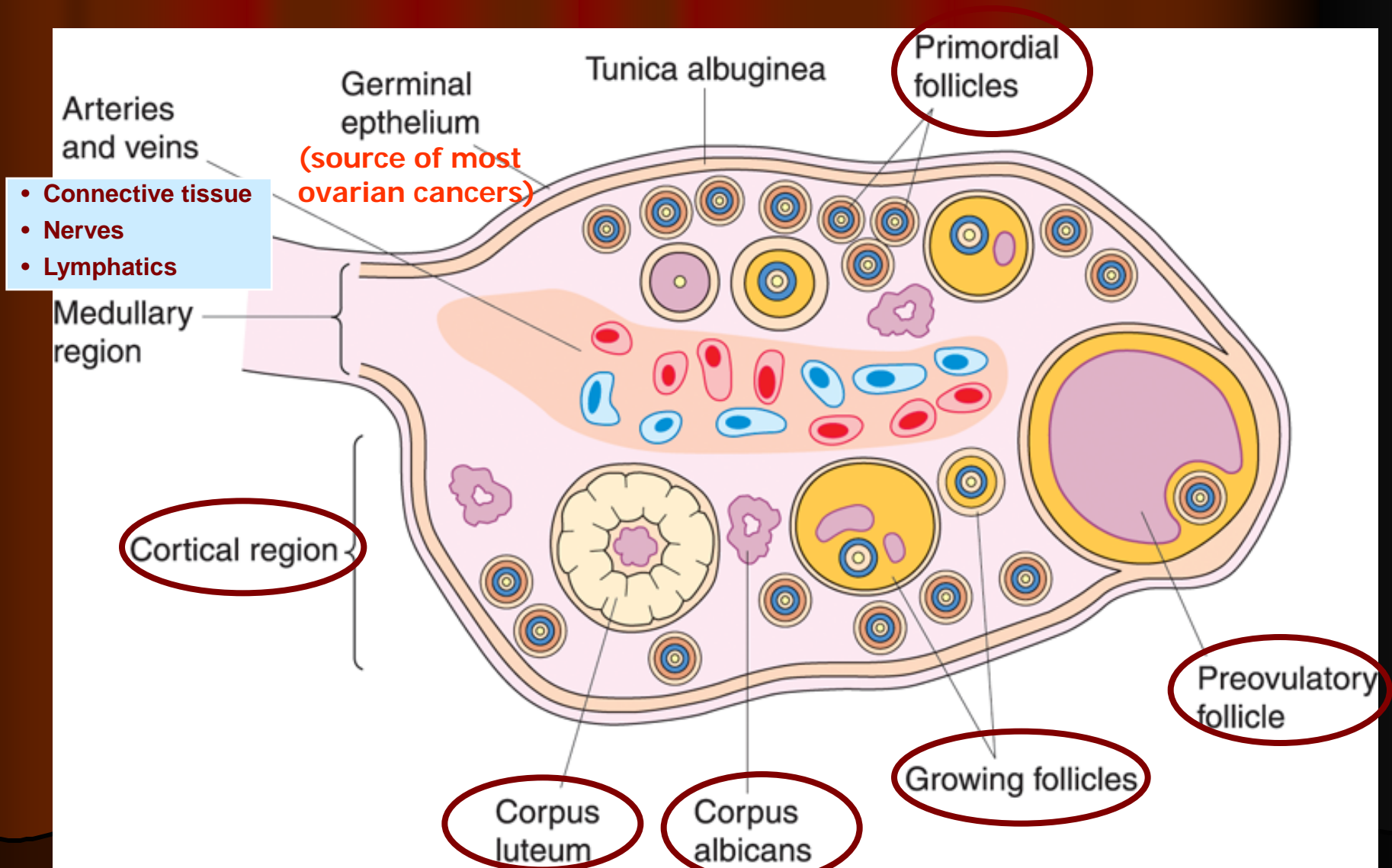
General Overview

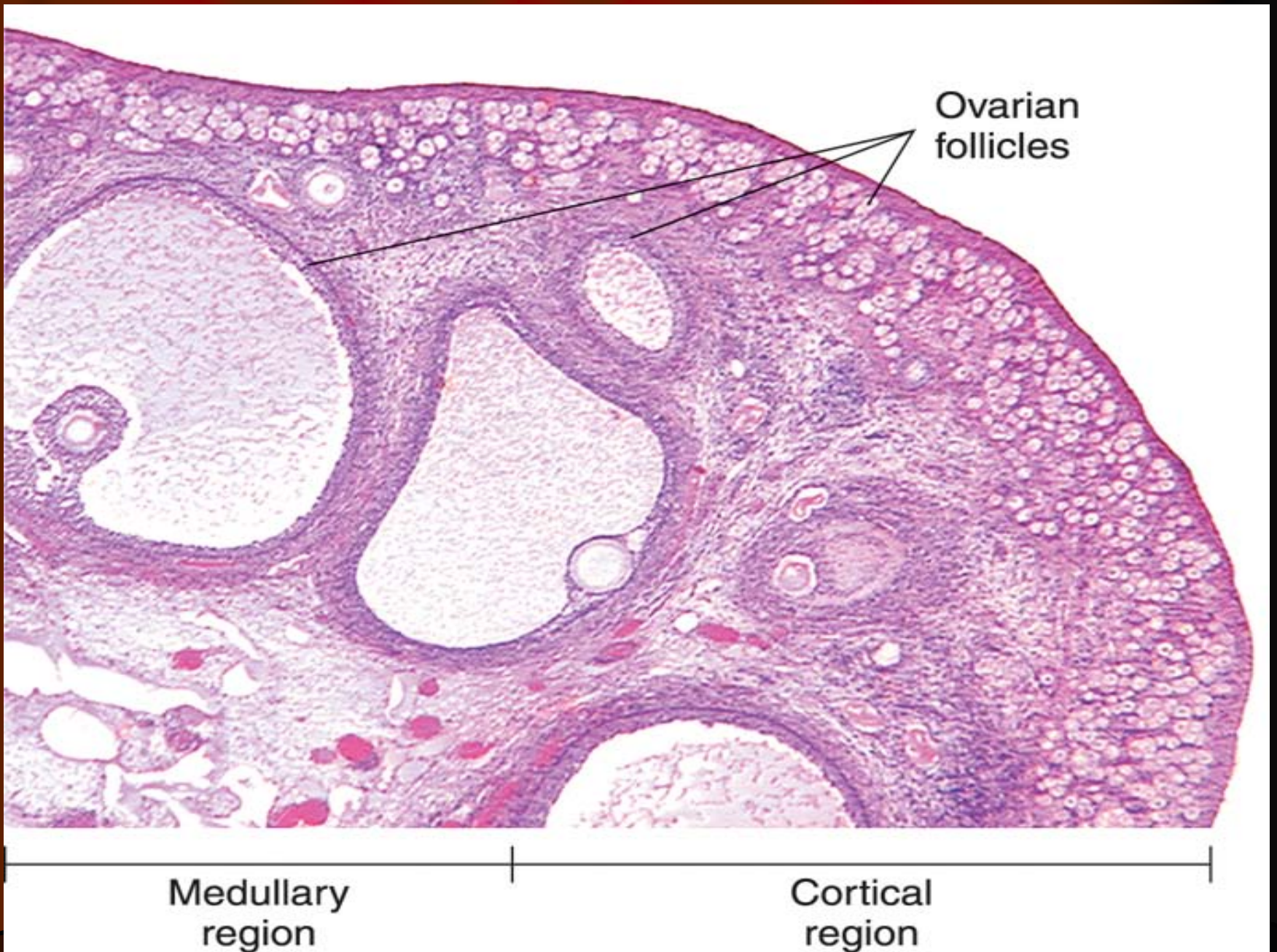
- **Internal organs**
 - Ovary
 - Uterine tube
 - Uterus
 - Cervix
 - Vagina
- **External genitalia**
 - Clitoris
 - Labia major and minor
 - Vestibule
 - Urethra
- **Mammary gland**

Female Reproductive System



I. The Structure of the Ovary

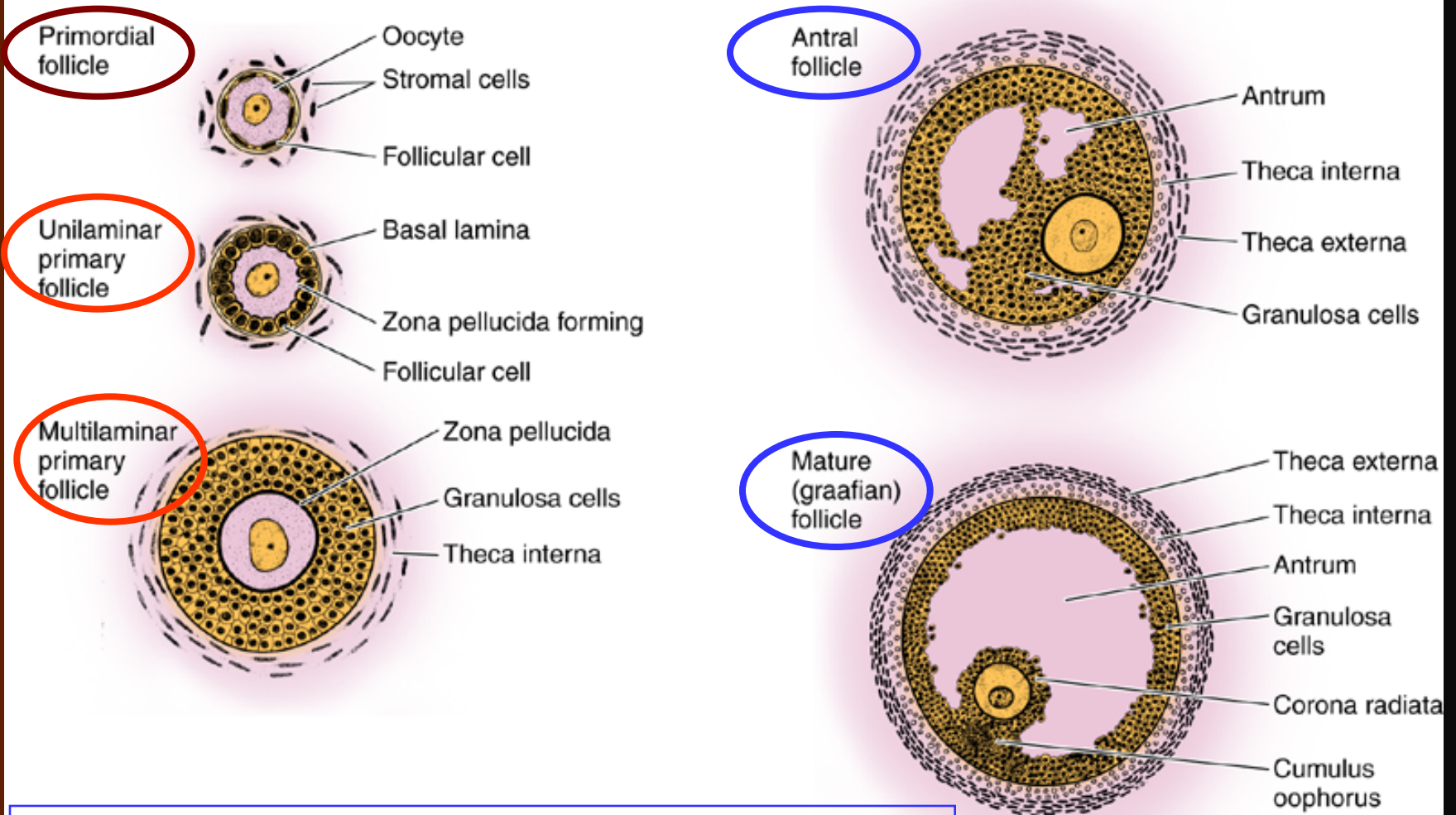




Question 1

- Elaborate the following contents:
 1. **Development and maturation** of
ovarian follicles

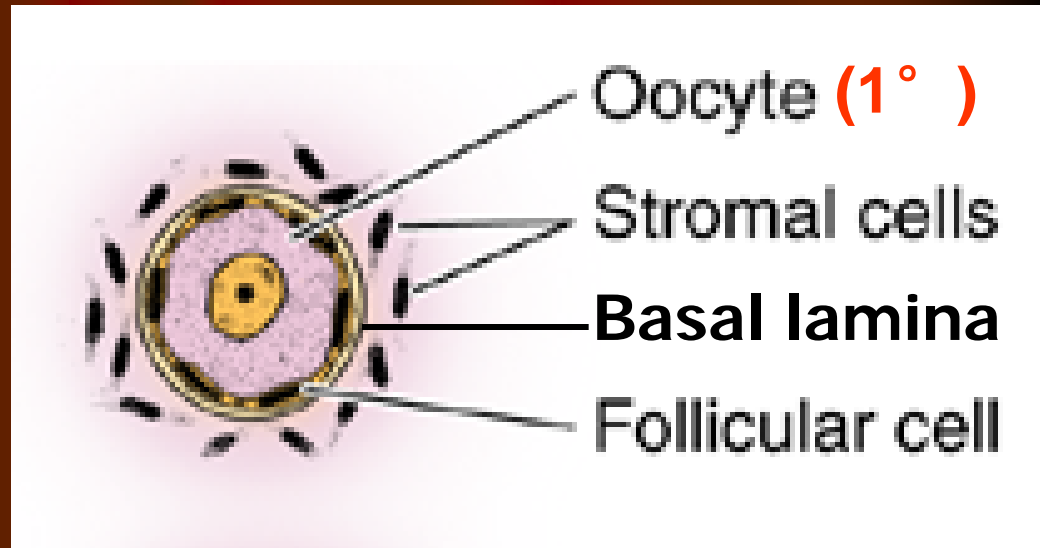
1. The Follicular Development



Primordial → Primary → Secondary → Mature

Primordial Follicle

1. Some 600,000 at birth
2. Many are lost through atresia before birth and before reaching puberty
3. After puberty, several primordial follicles are stimulated to growth at beginning of each cycle
4. Usually only one reaches full maturity and ovulated/cycle
5. Others undergo atretic [degenerative] changes at different stages



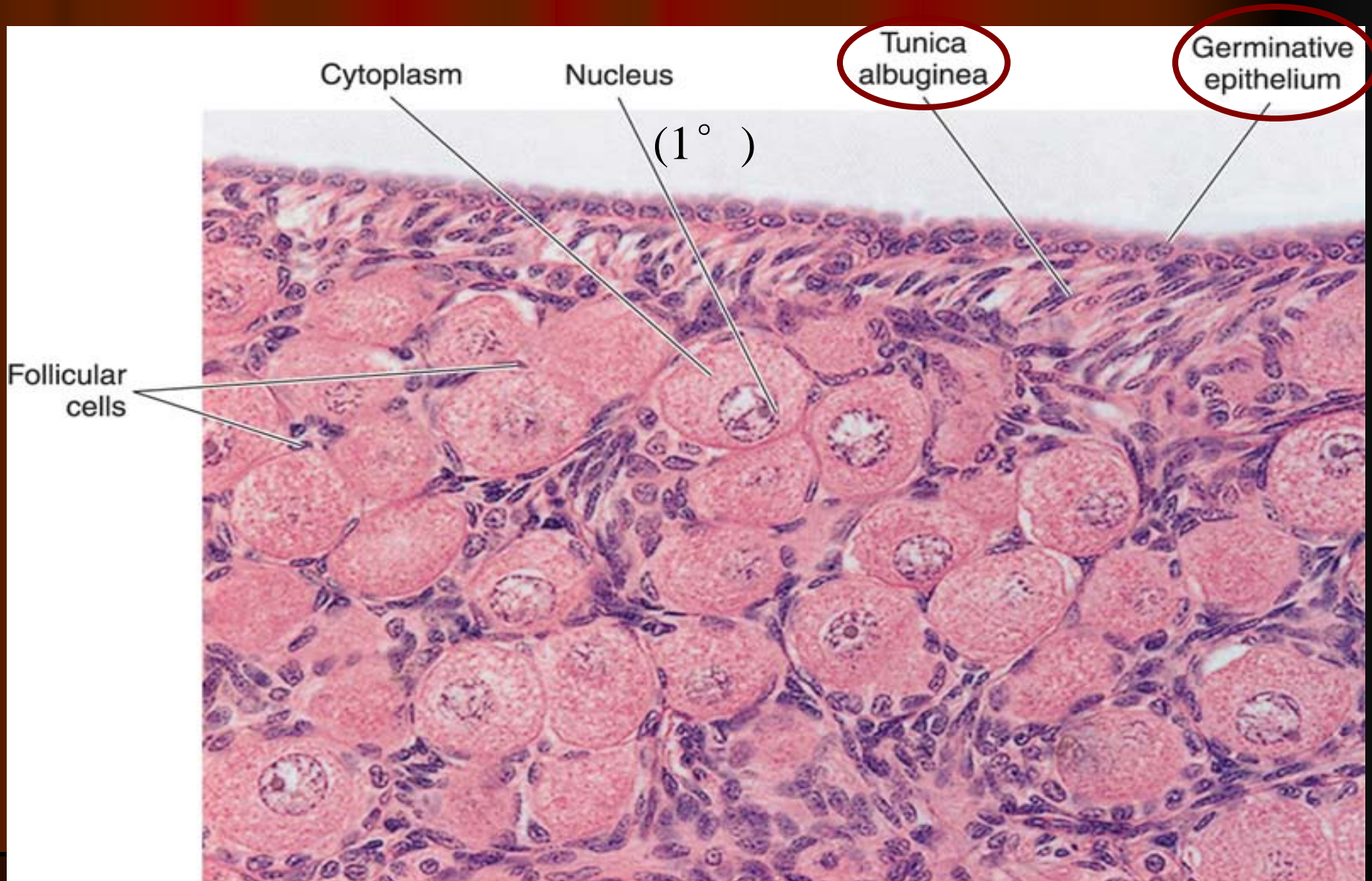
Nucleus of oocyte
(arrested at 1st meiotic prophase, before birth)

No zona pellucida

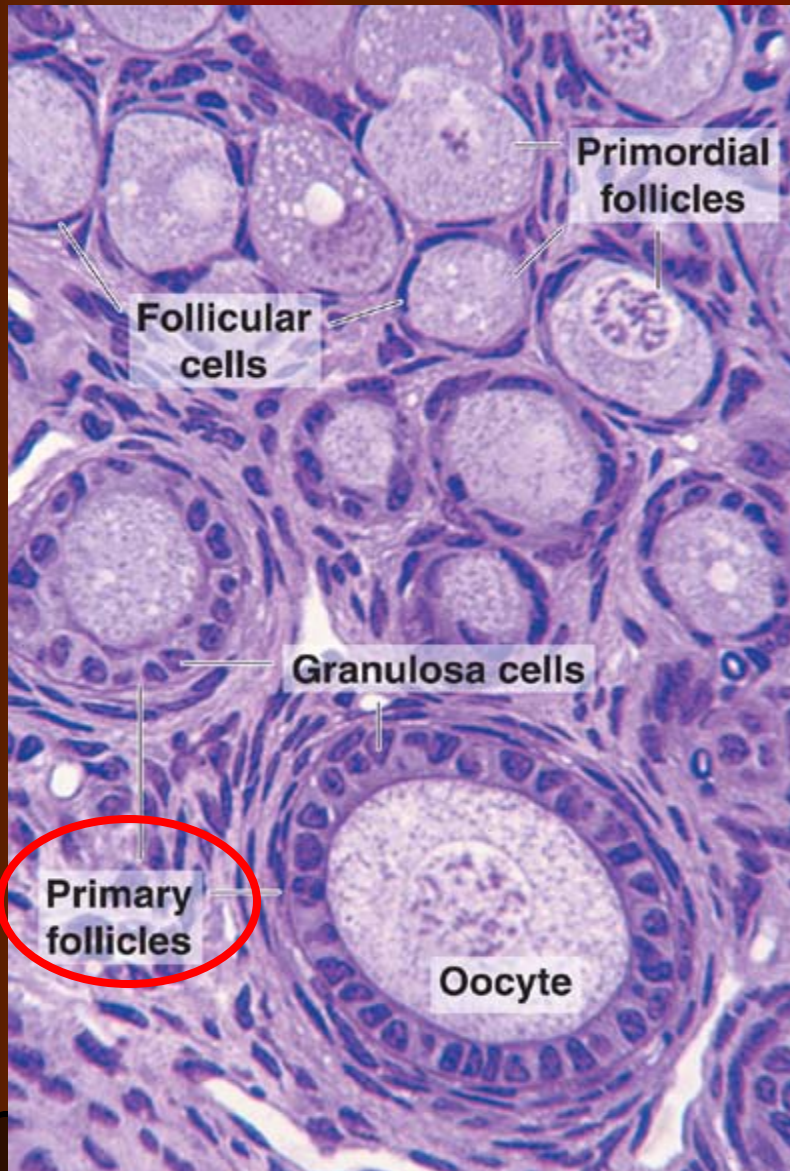
Single layer of squamous follicular cells

The **only** type in cortex **before puberty**; but **no** follicles in ovary **after menopause**

Primordial Follicle



Unilaminar Primary Follicle



Zona pellucida **forming**

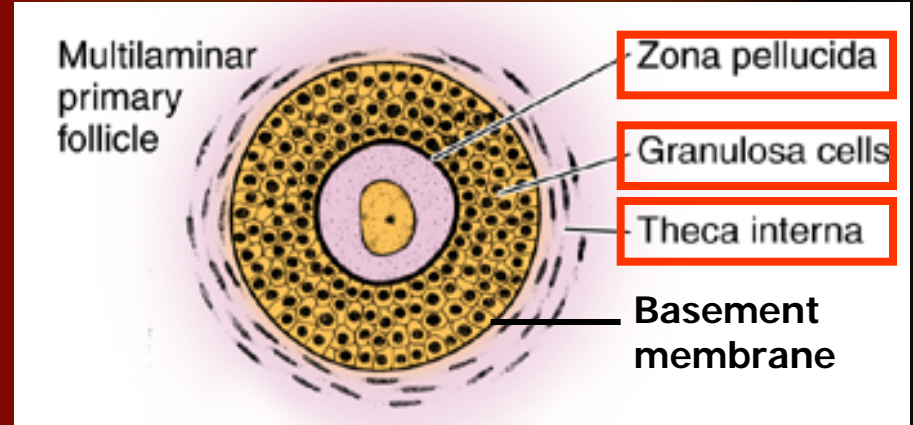
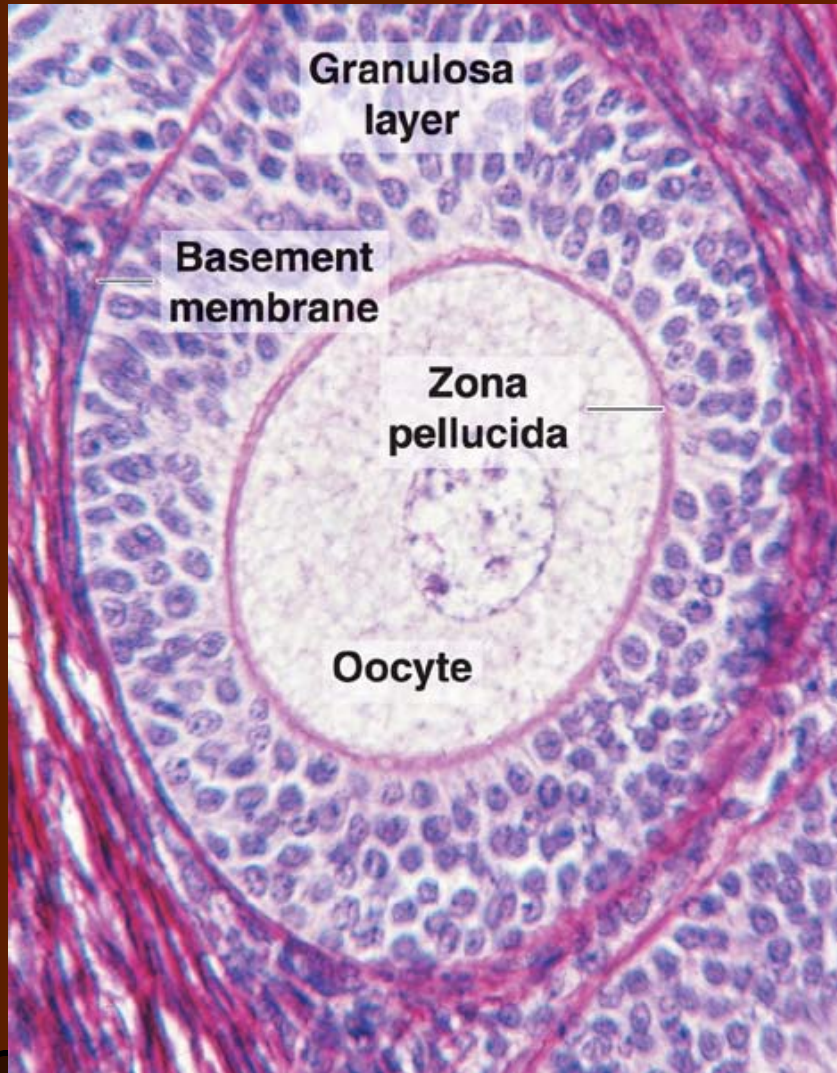
+

Single layer of cuboidal or columnar follicular cells

+

Basal lamina

Multilaminar Primary or Preantral Follicle



Zona pellucida
formed



Zona pellucida

+

More than one
layer of
follicular cells



**Granulosa
cells or layer**

+

Basement membrane

+

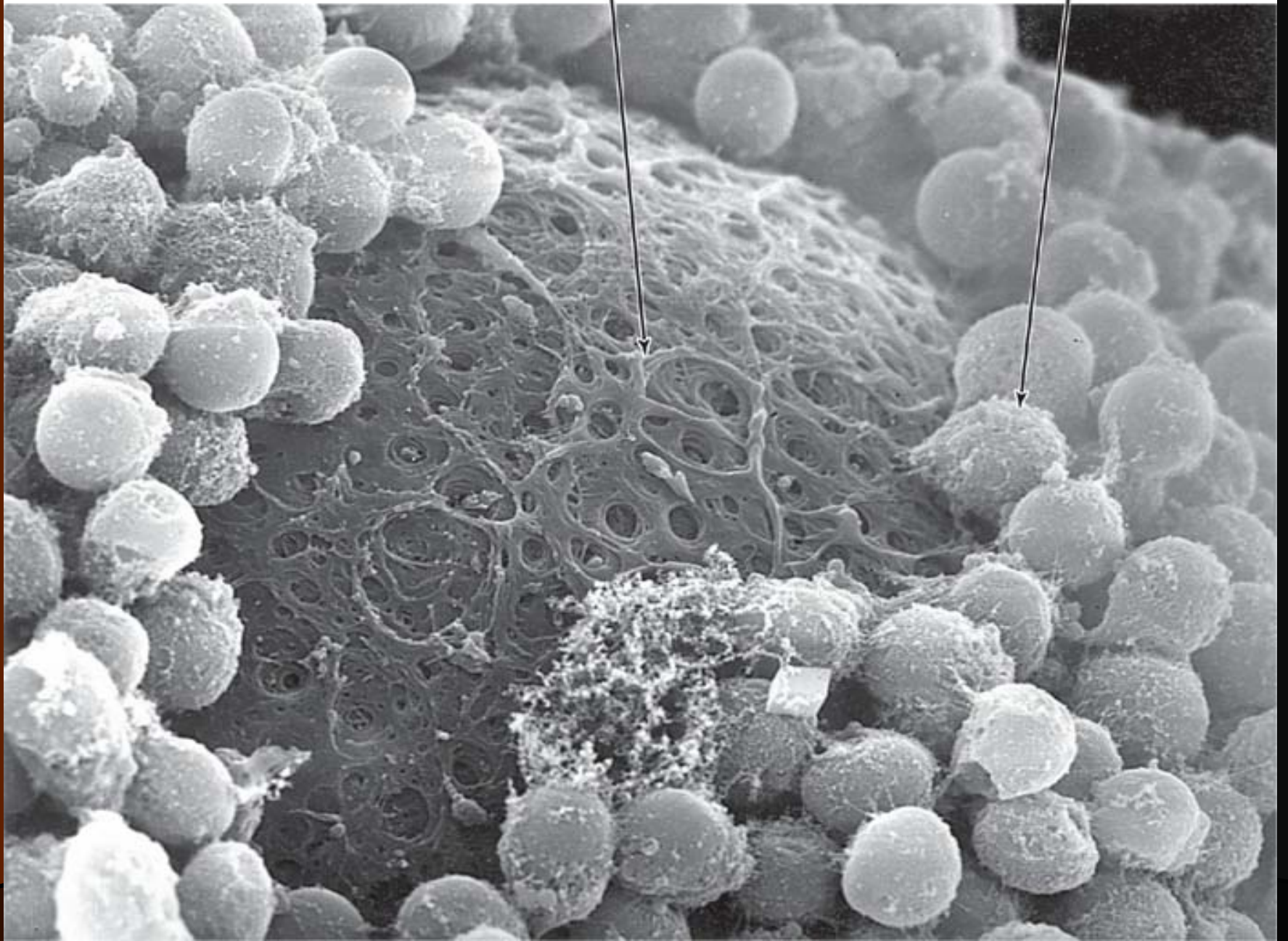
Appearance of
theca cells



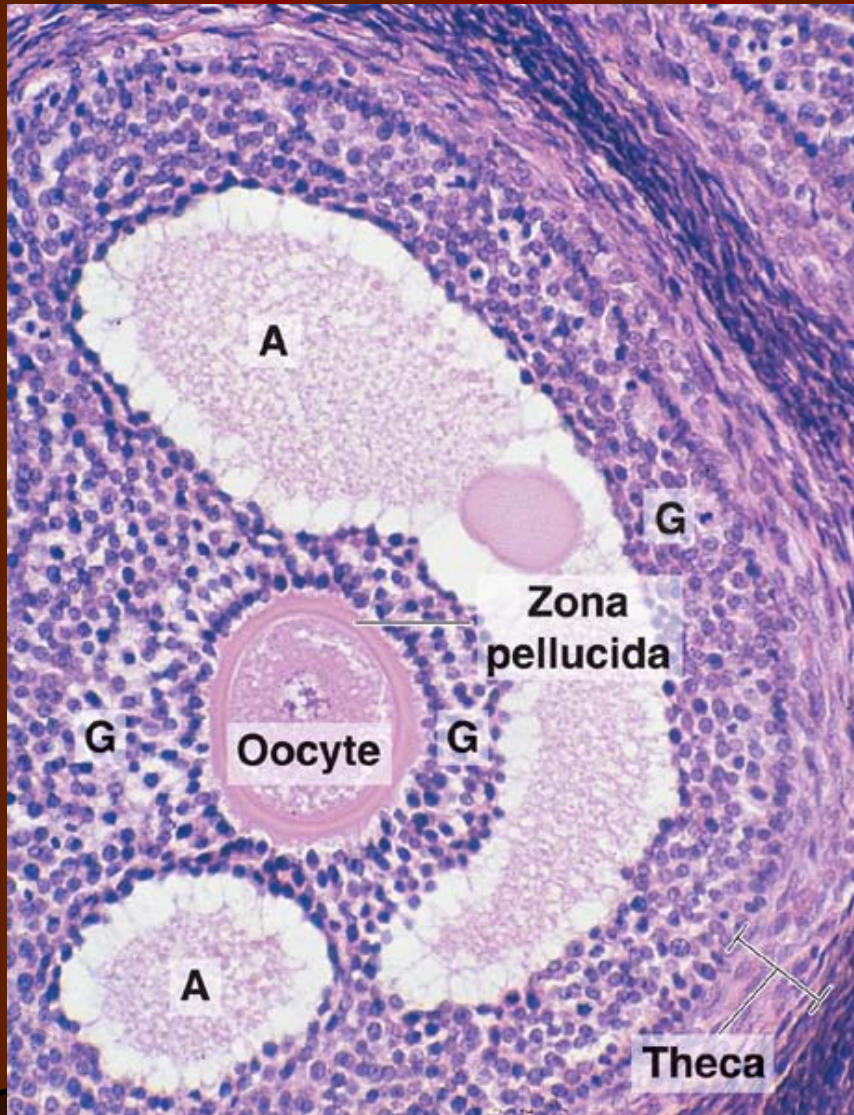
Theca layer

Oocyte

Follicular cells



Antral or Secondary Follicle



Granulosa cells of primary follicle



Liquid-containing Antrum

Cumulus oophorus

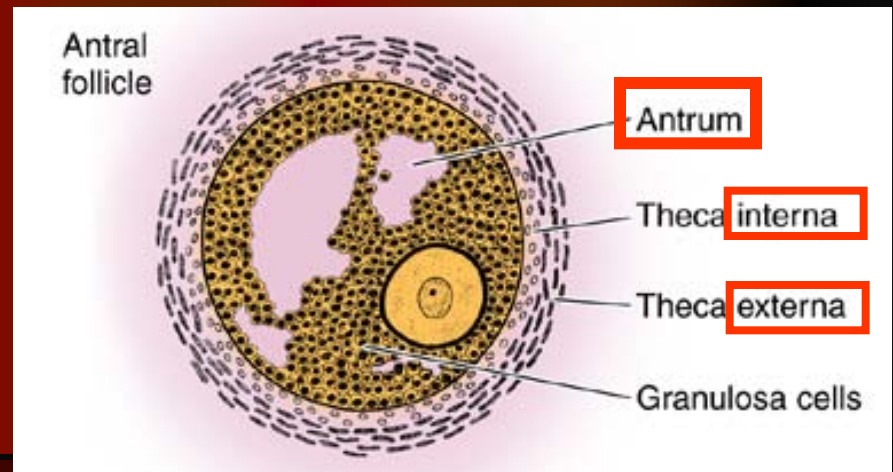
Corona radiata

Theca layer of primary follicle

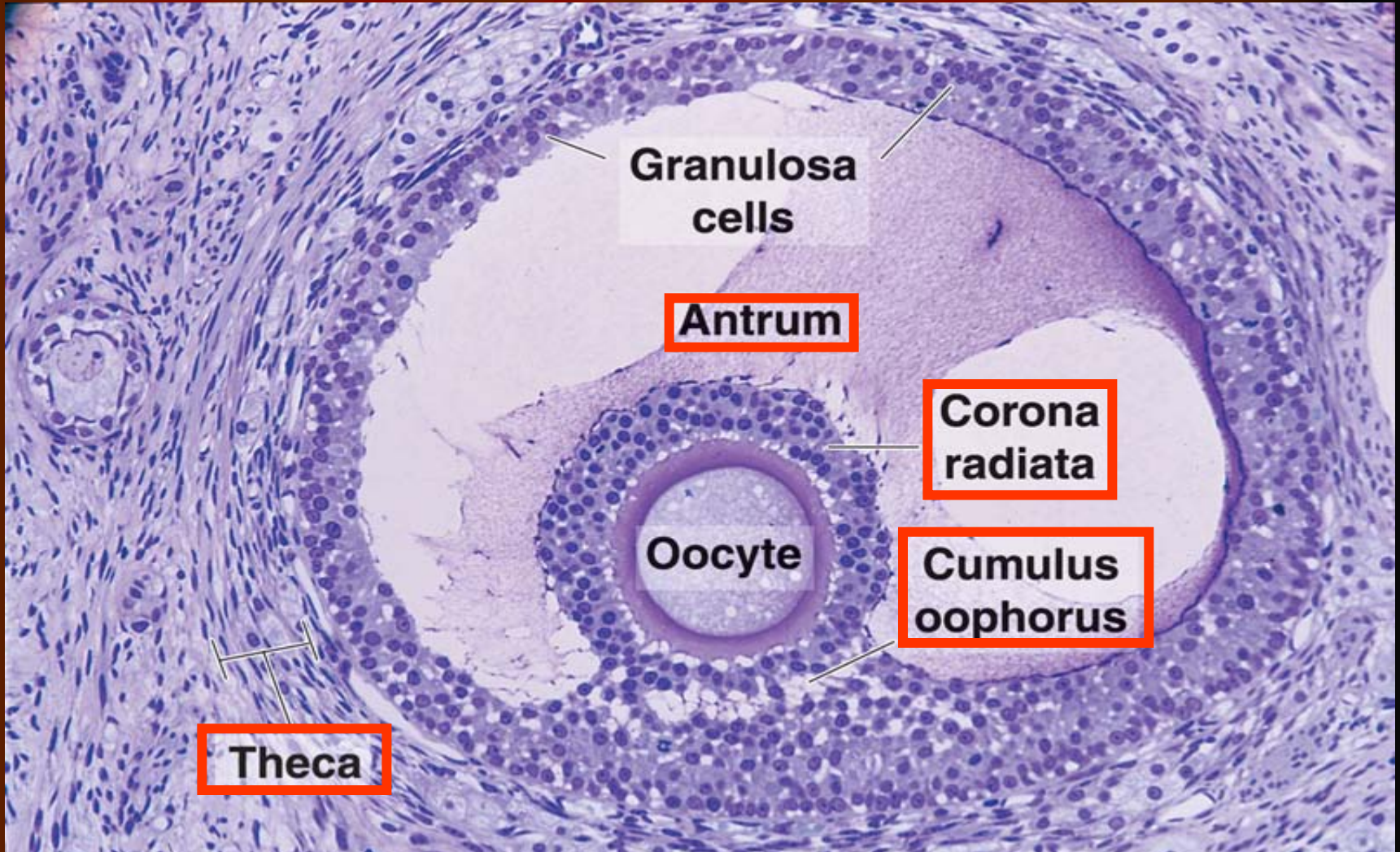


Theca interna

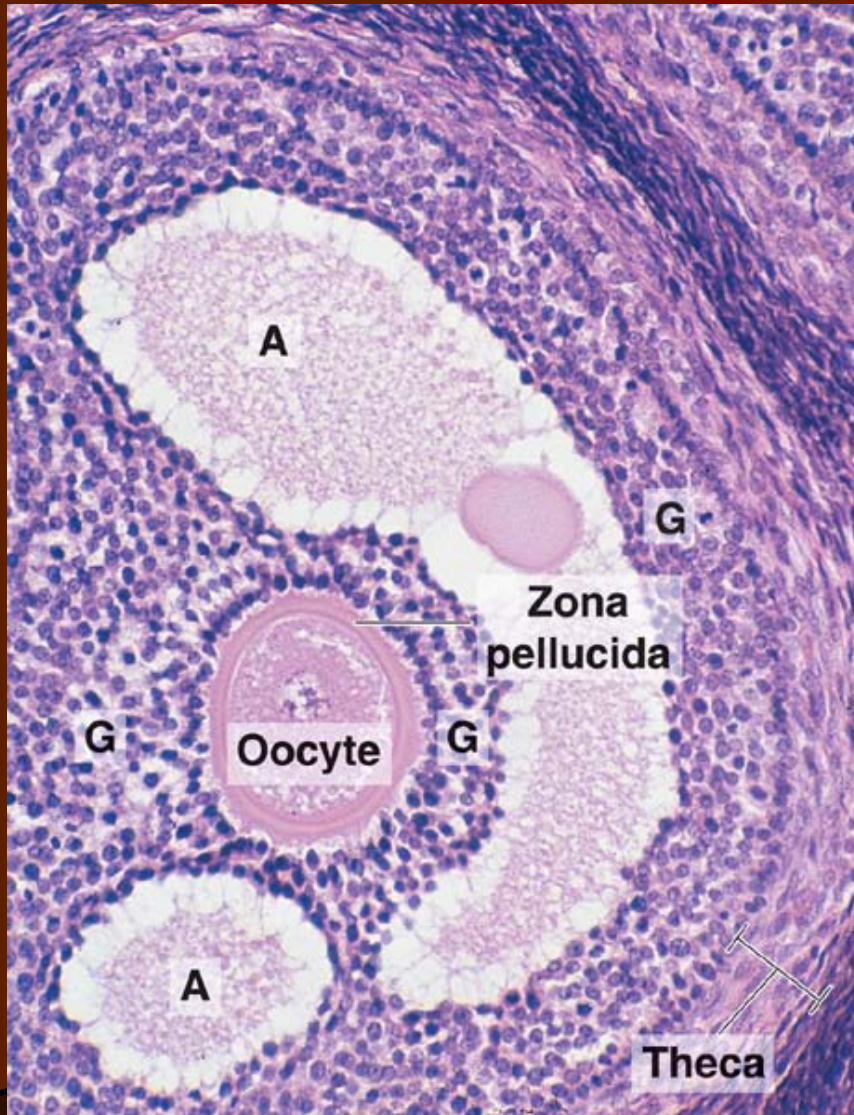
Theca externa



Antral or Secondary Follicle



Antral or Secondary Follicle



Granulosa cells of primary follicle



Liquid-containing Antrum

Cumulus oophorus

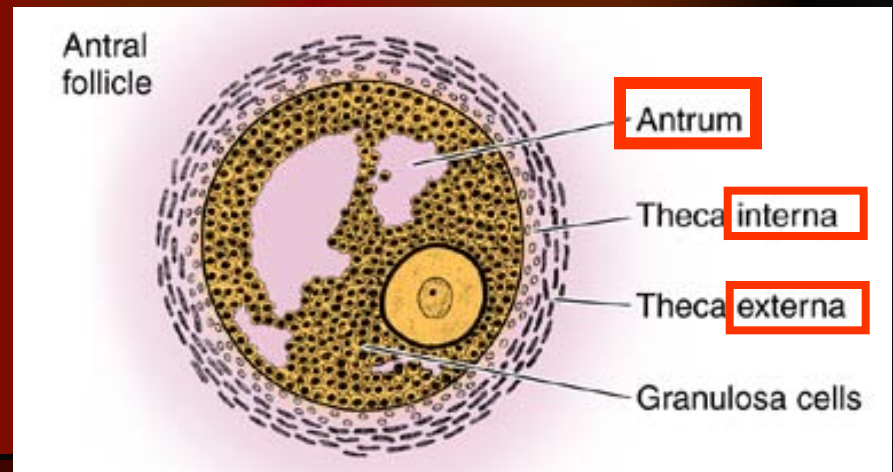
Corona radiata

Theca layer of primary follicle

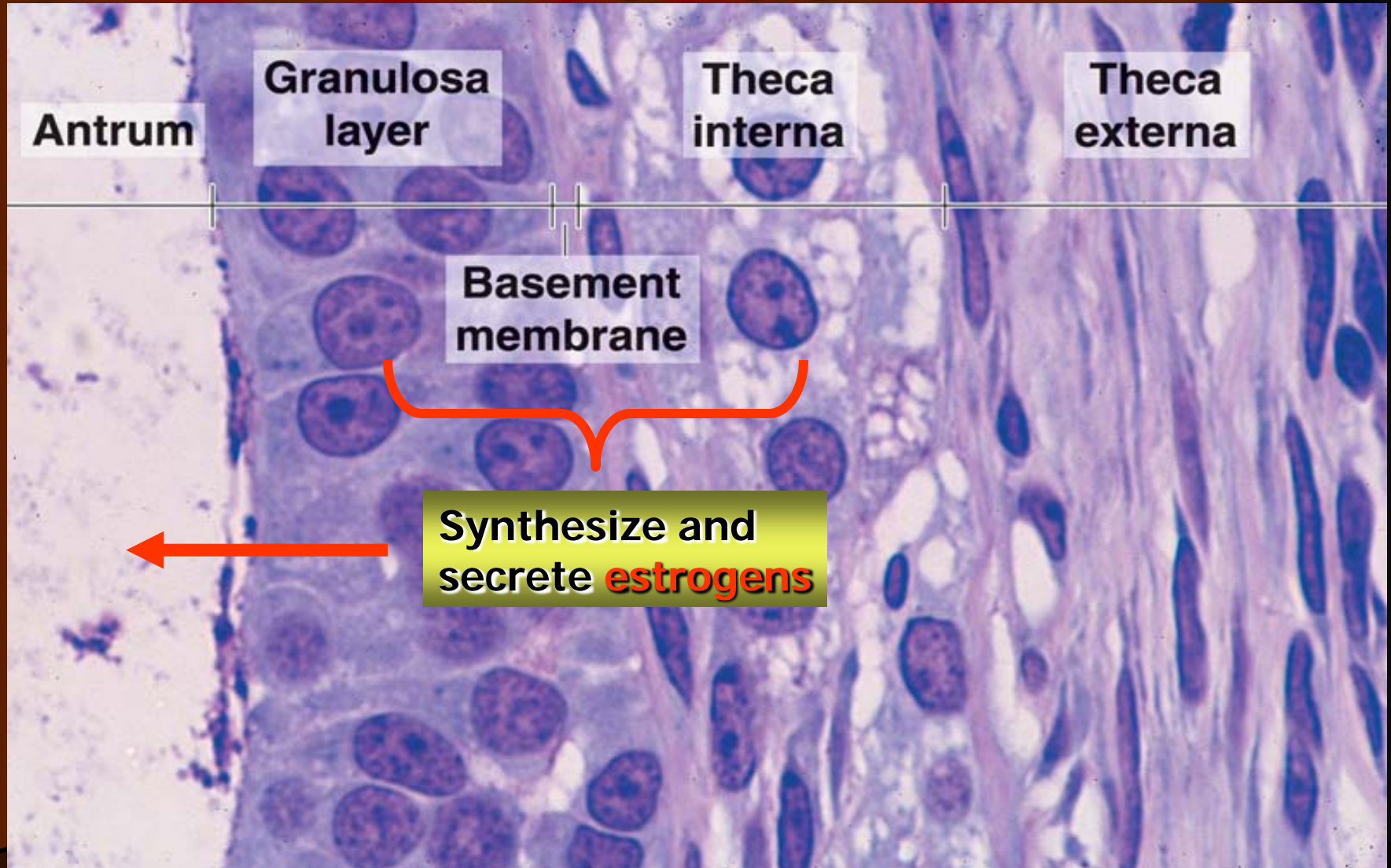


Theca interna

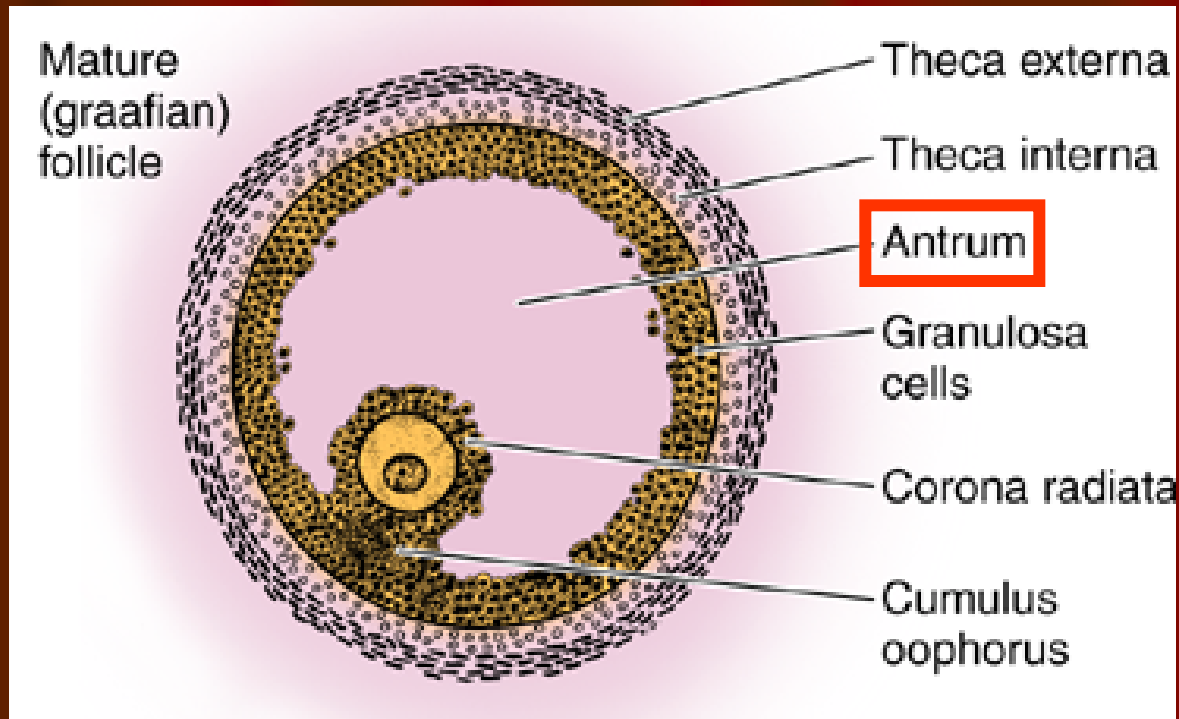
Theca externa



The Part of the Wall of an Antral Follicle



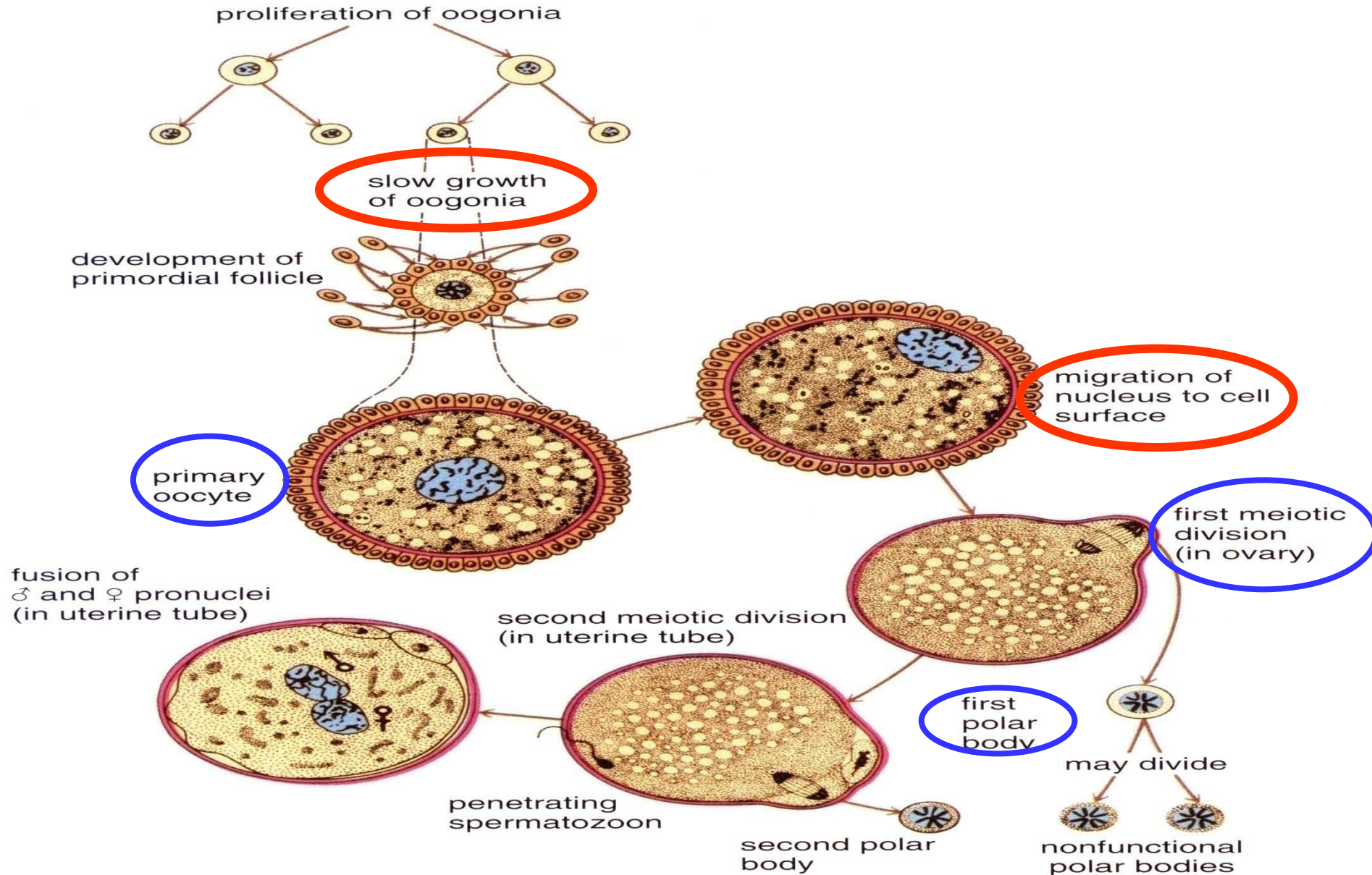
Mature or Graafian Follicle



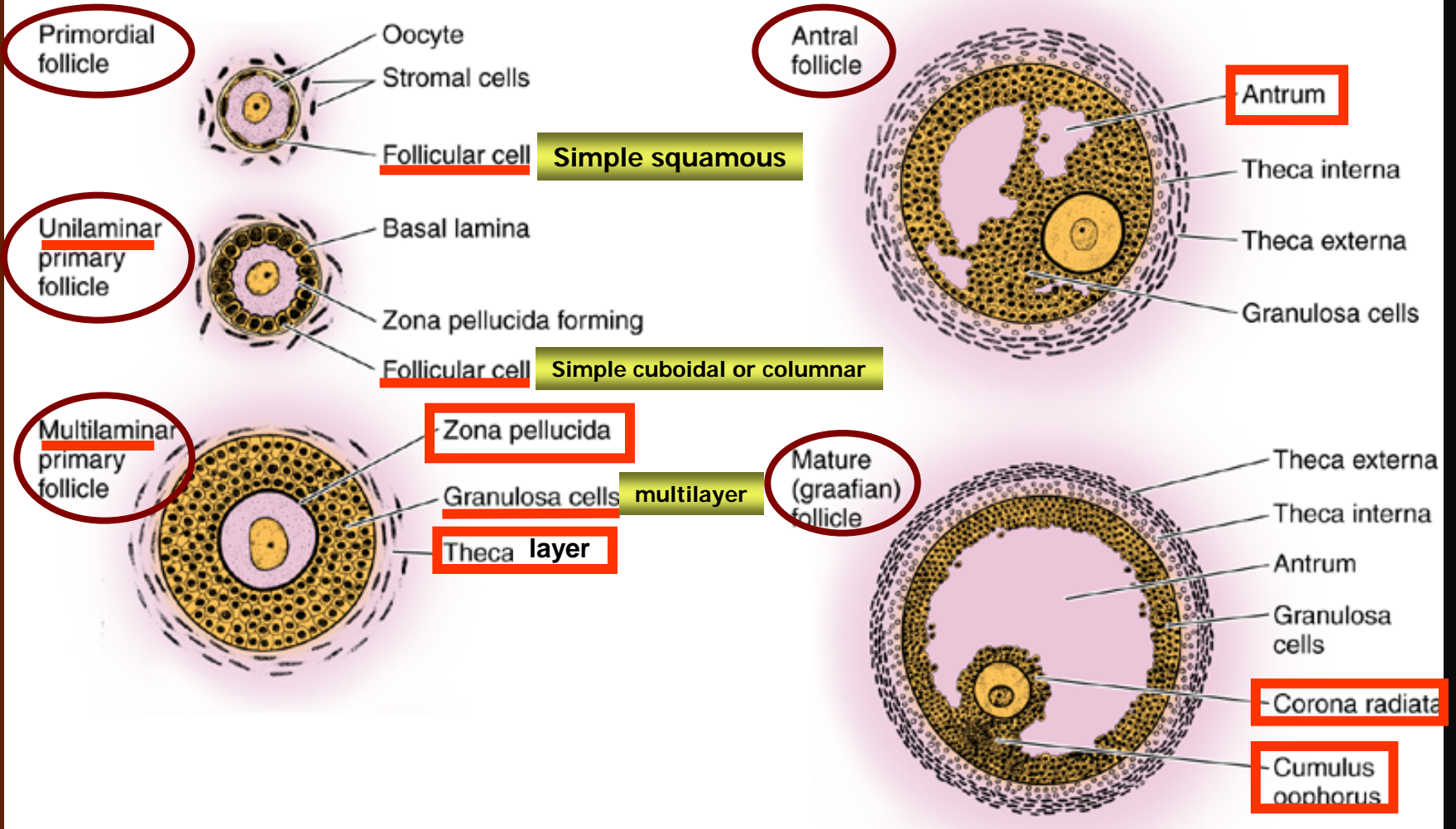
- **10 to 25 mm** in diameter
- **Large antrum**
- **Causing a bulge on the surface of the ovary**

Between 12 and 24 hours **after LH surge (before ovulation)**, the 1st meiotic division of the primary oocyte resumes, and **the 2nd** oocyte arrested **at MII** and **the 1st** polar body were **formed**.

Diagram illustrating changes that occur during growth, maturation, and fertilization of the oocyte



Summary I.1



Question 2 & 3

- Elaborate the following contents:

2. Ovulation

3. **Structure** and **function** of corpus

luteum

2. Ovulation

● Characteristics

- The rupture of the part of the wall of the mature follicle
- Liberation of the oocyte with zona pellucida, corona radiata and cumulus oophorus

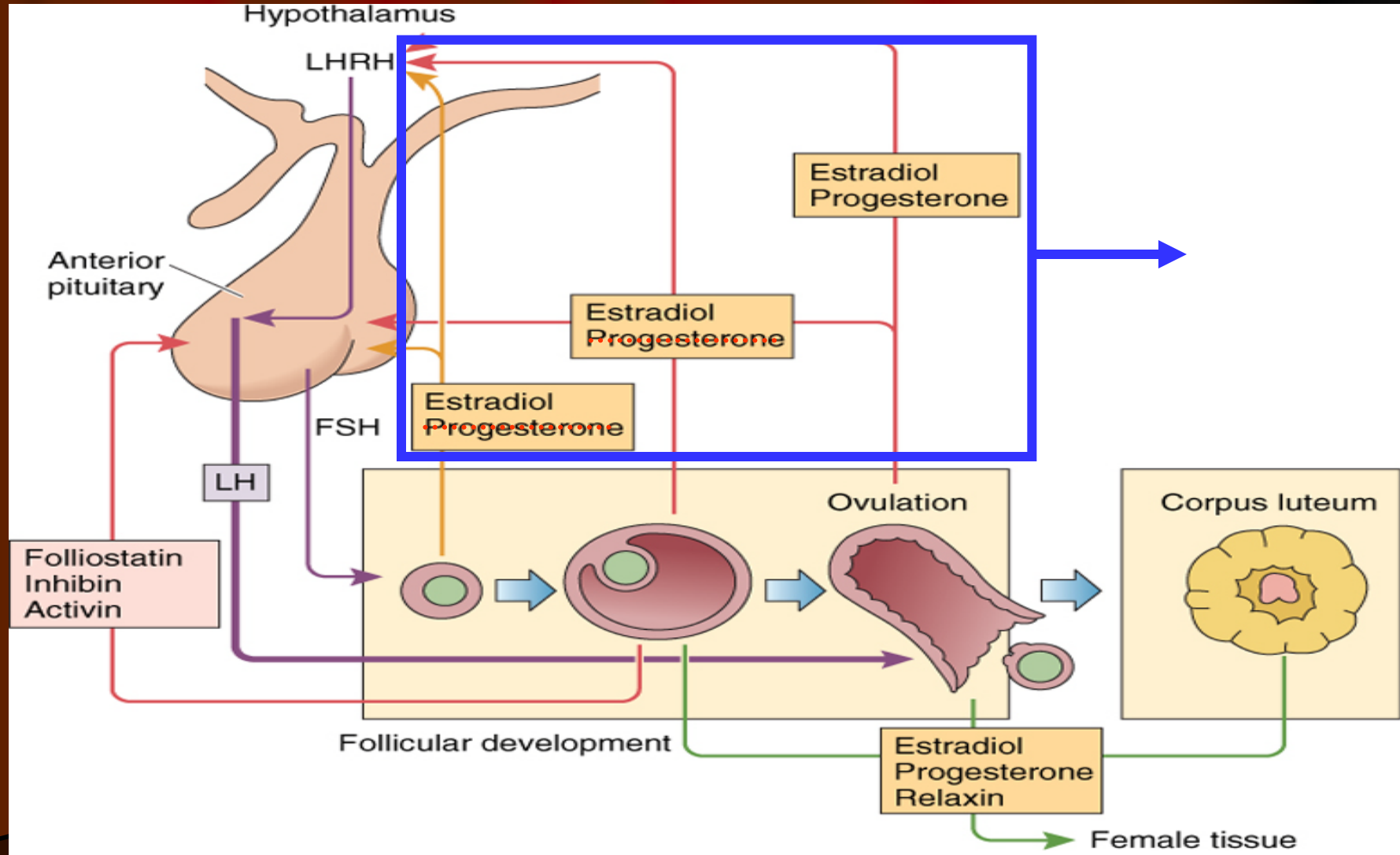
● Frequency and amount during each cycle

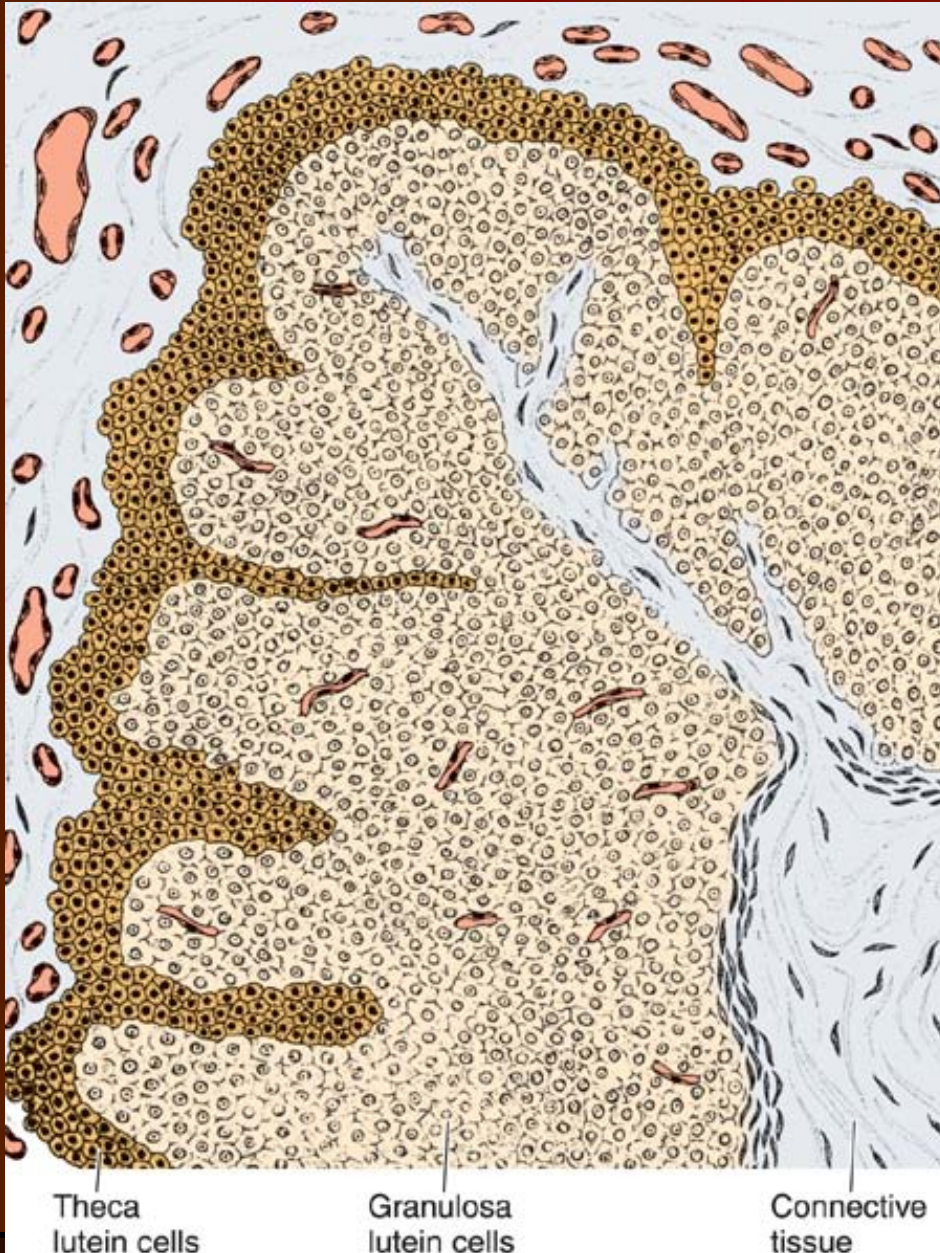
- Once around the 14th day of a 28-day cycle
- Only one oocyte, alternation of left and right side
- Sometimes, none; sometimes, two or more

● Consequence

- Between 12 and 24 hours after LH surge (before ovulation)
 - the 1st meiotic division of the primary oocyte resumes
 - the 2nd oocyte arrested at MII
 - the 1st polar body formed.

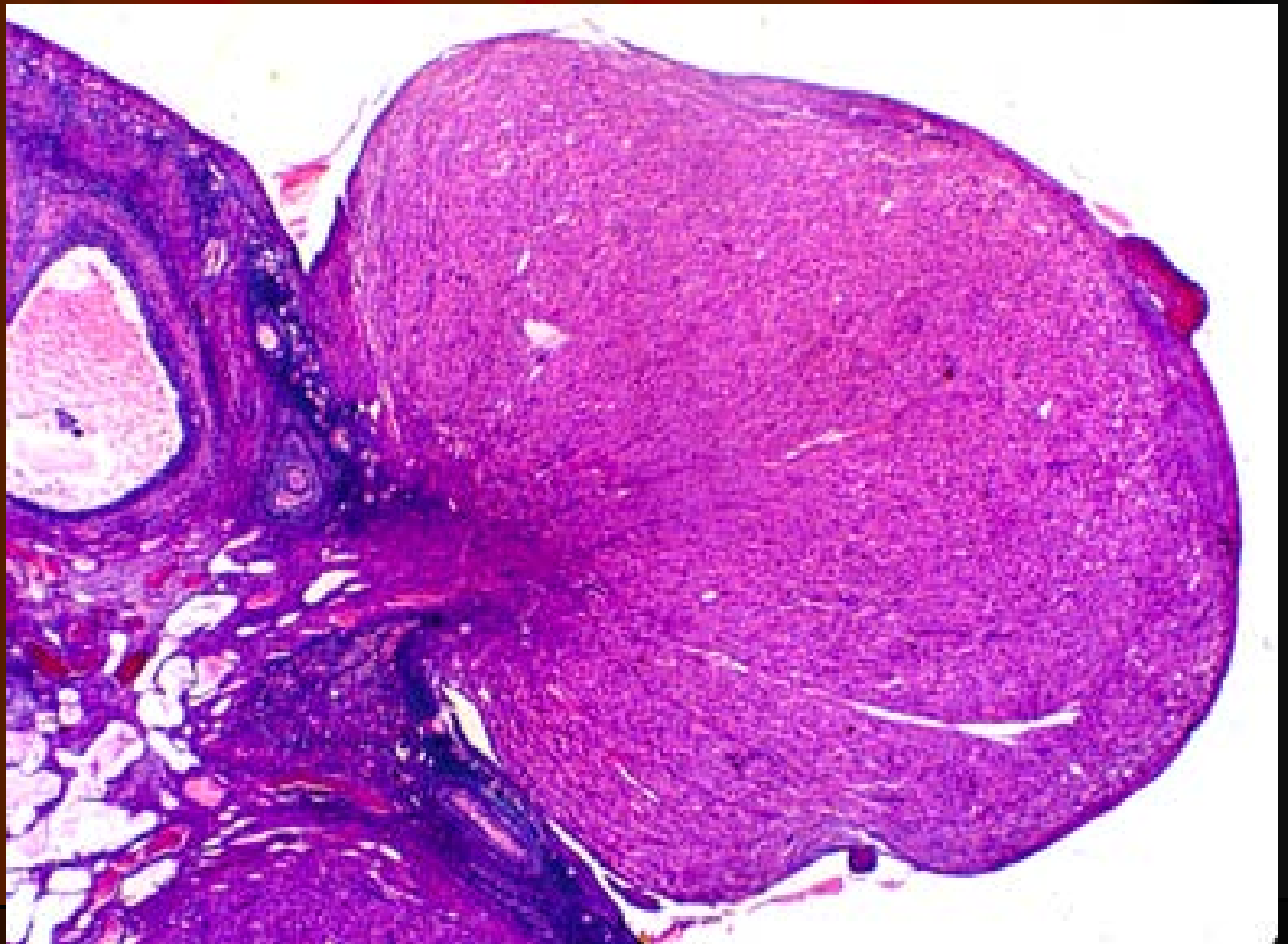
Hormonal Control of Ovarian Functions



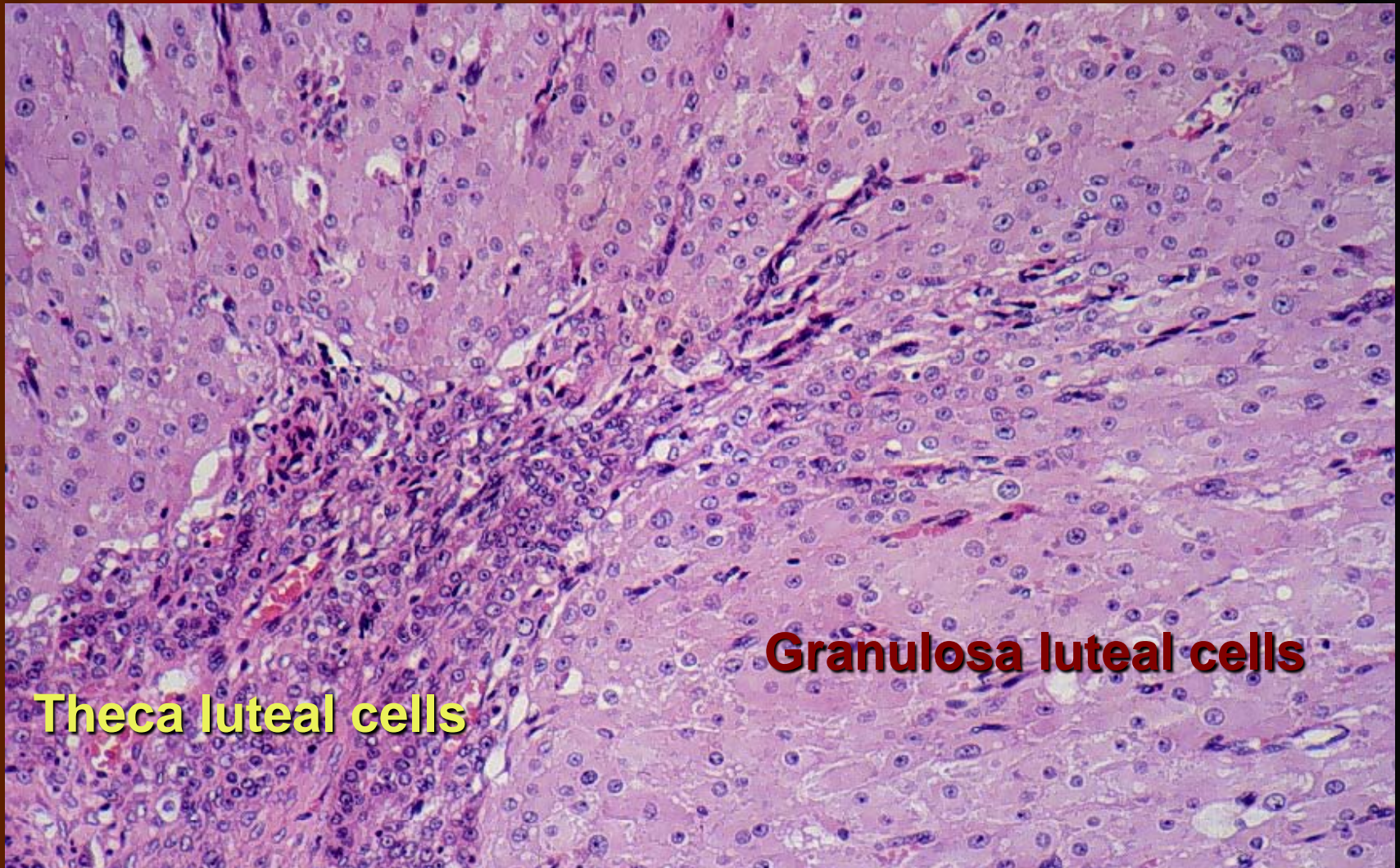


Corpus Luteum

- **Granulosa luteal cells**
 - Larger
 - more centrally located
 - Paler stained
 - Typical steroidogenic cells
- **Theca luteal cells**
 - Smaller
 - Peripherally located
 - More darkly stained
 - Typical steroidogenic cells



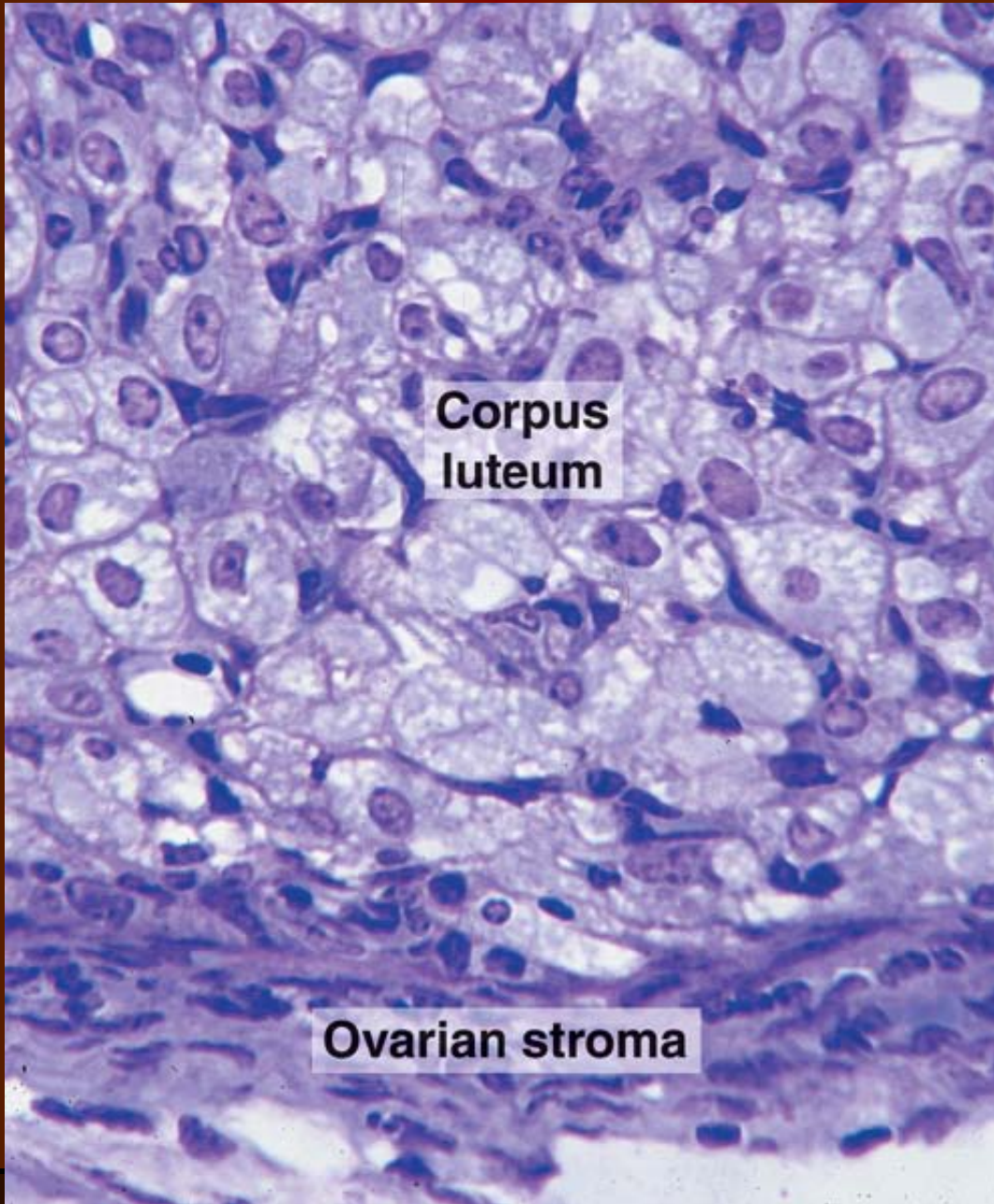
Corpus Luteum



Theca luteal cells

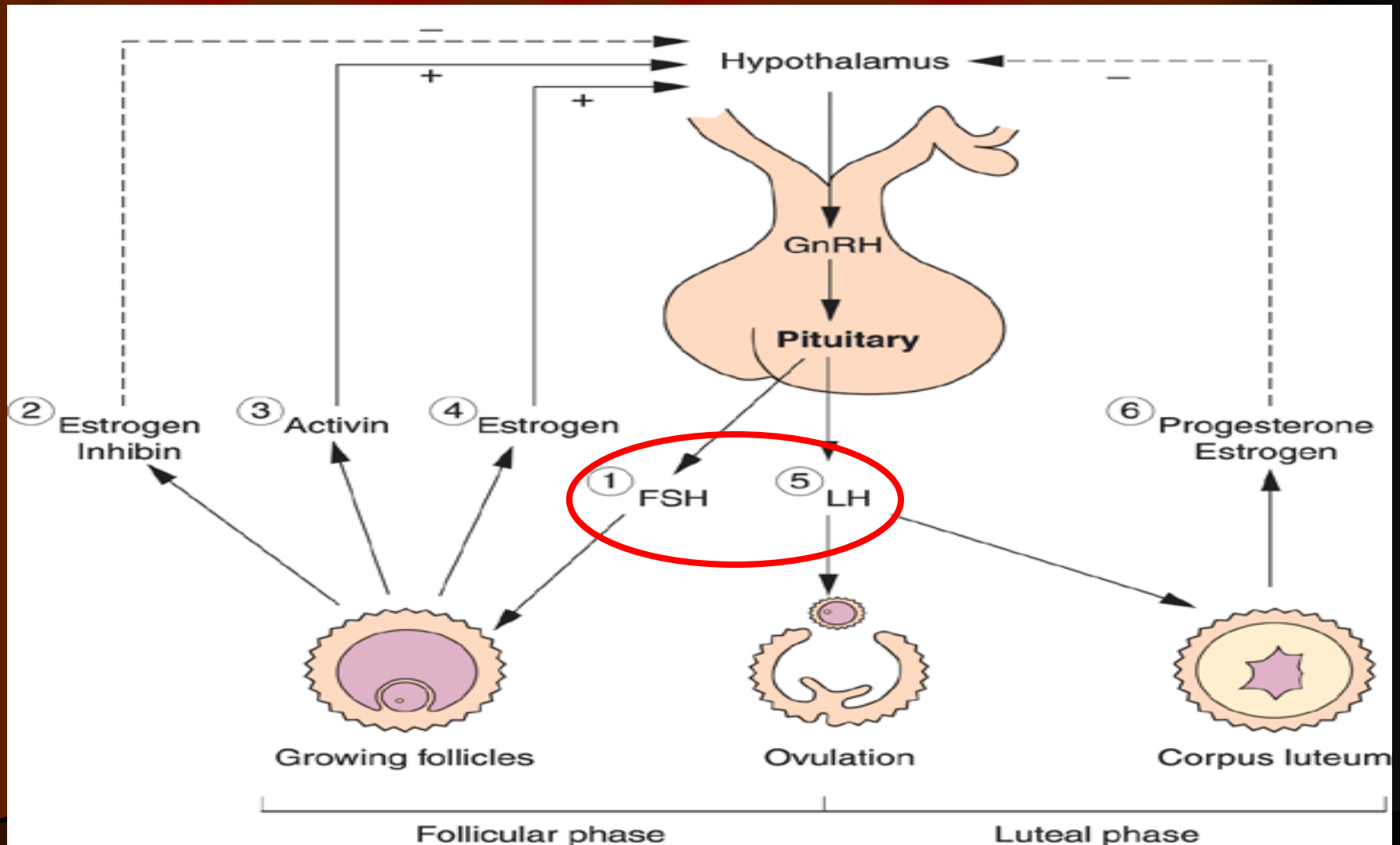
Granulosa luteal cells

Corpus Luteum



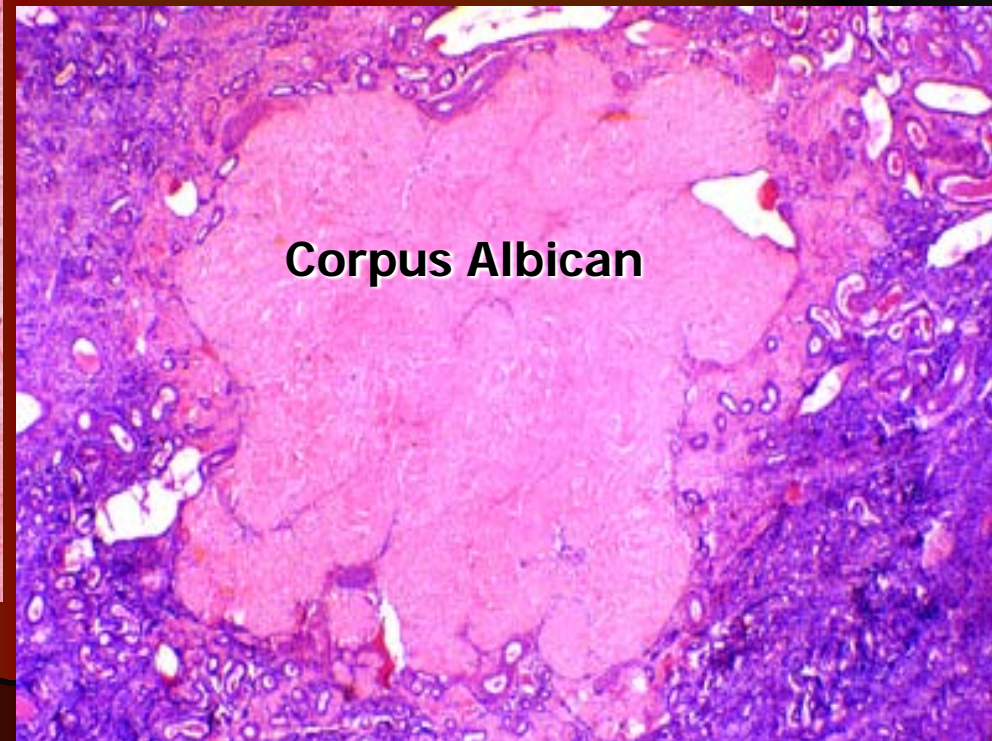
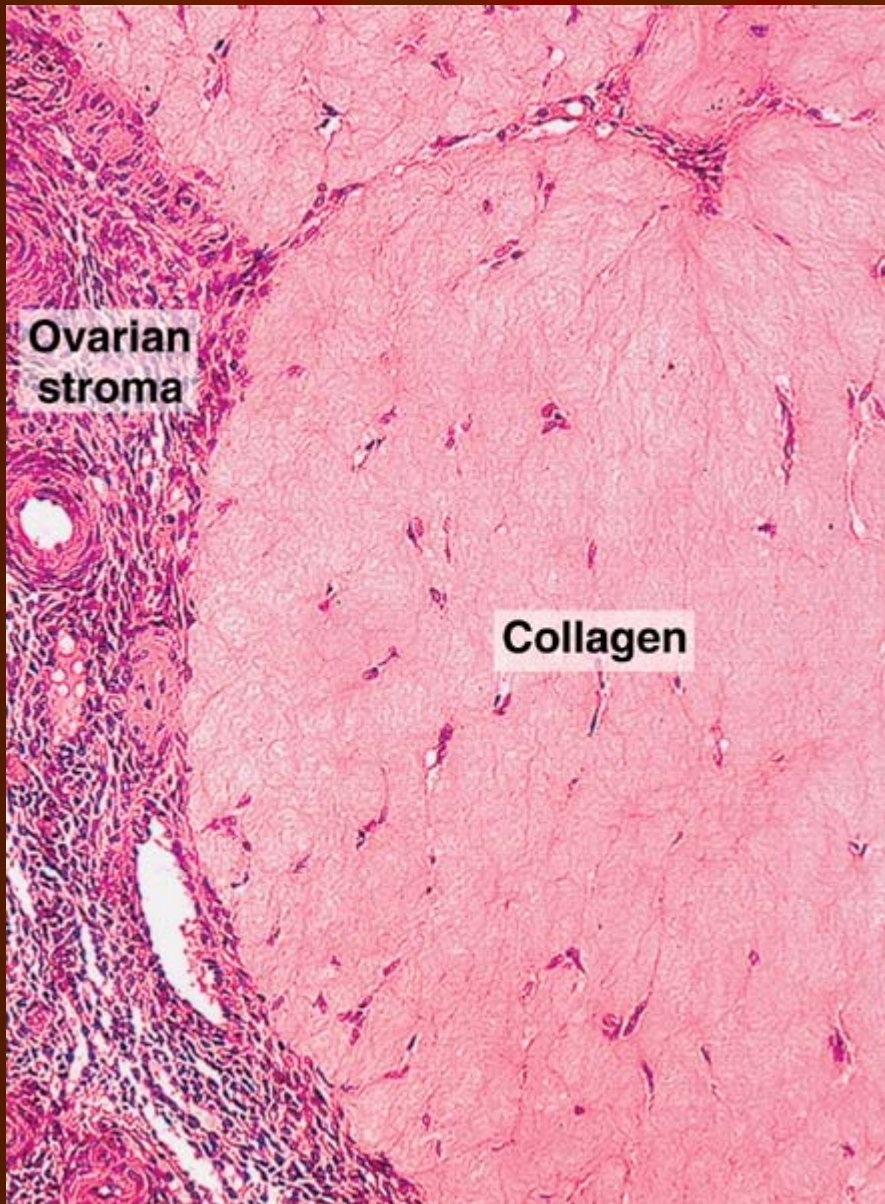
- **Granulosa luteal cells**
 - **Larger**
 - **more centrally located**
 - **Paler stained**
 - **Typical steroidogenic cells**
 - **Secrete P and relaxin**
 - **Secrete E collaborating with theca luteal cells**

Hormonal Control of Ovarian Functions



Corpus Albican

- If unfertilized
 - **Corpus luteum of menstruation-formed** will degenerate after 14 days and be replaced by collagen, forming white body
- If fertilized
 - **Corpus luteum of pregnancy-formed** will degenerate after 6 months and be replaced by collagen, forming white body

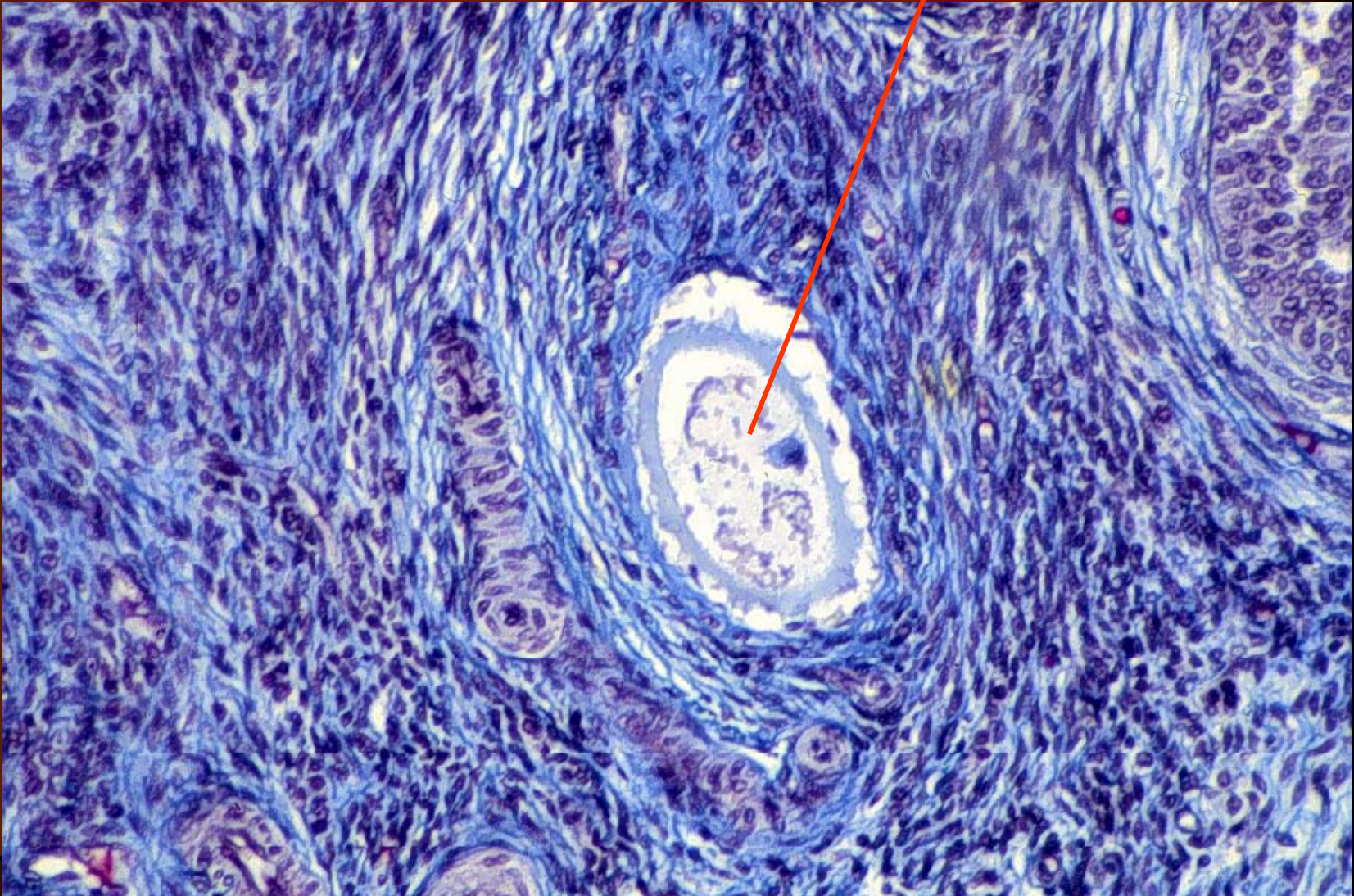


Follicular Atresia

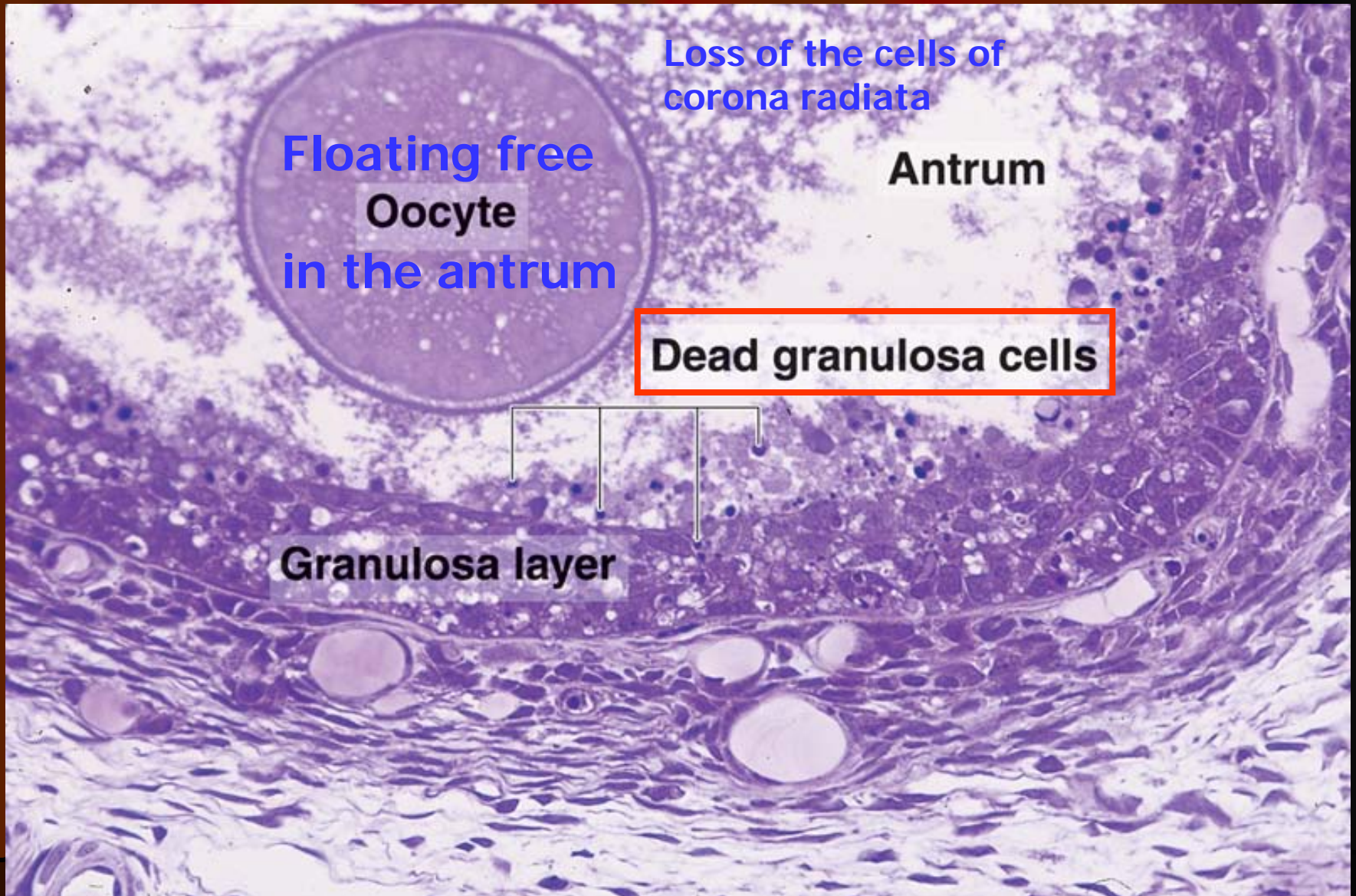
- **Most ovarian follicles are lost by atresia mediated by apoptosis of granulosa cells DURING**
 - Fetal development
 - Early postnatal life
 - Puberty
- **After puberty,**
 - Groups of follicles begin to mature during each menstrual cycle.
 - BUT only one follicle completes its maturation.
 - Thus, at any stage a follicle may undergo atresia
- **Features:**
 - Cessation of mitosis in the granulosa cells
 - Detachment of granulosa cells from the basal lamina
 - Death of the oocyte and granulosa cells
 - Invasion of macrophages to the follicle
 - Occupation of fibroblast in the follicle

Atretic Follicle

Oocyte (degenerating)



An Atresic Antral Follicle





Follicular cells

Zona pellucida

Interstitial Cells

1. Derived from atretic follicle, theca cells
2. **In human, very few in adult ovary**
3. More numerous in early phase of puberty, secrete estrogen
4. **Numerous in ovary of rodents**

Theca cells

Interstitial Cells

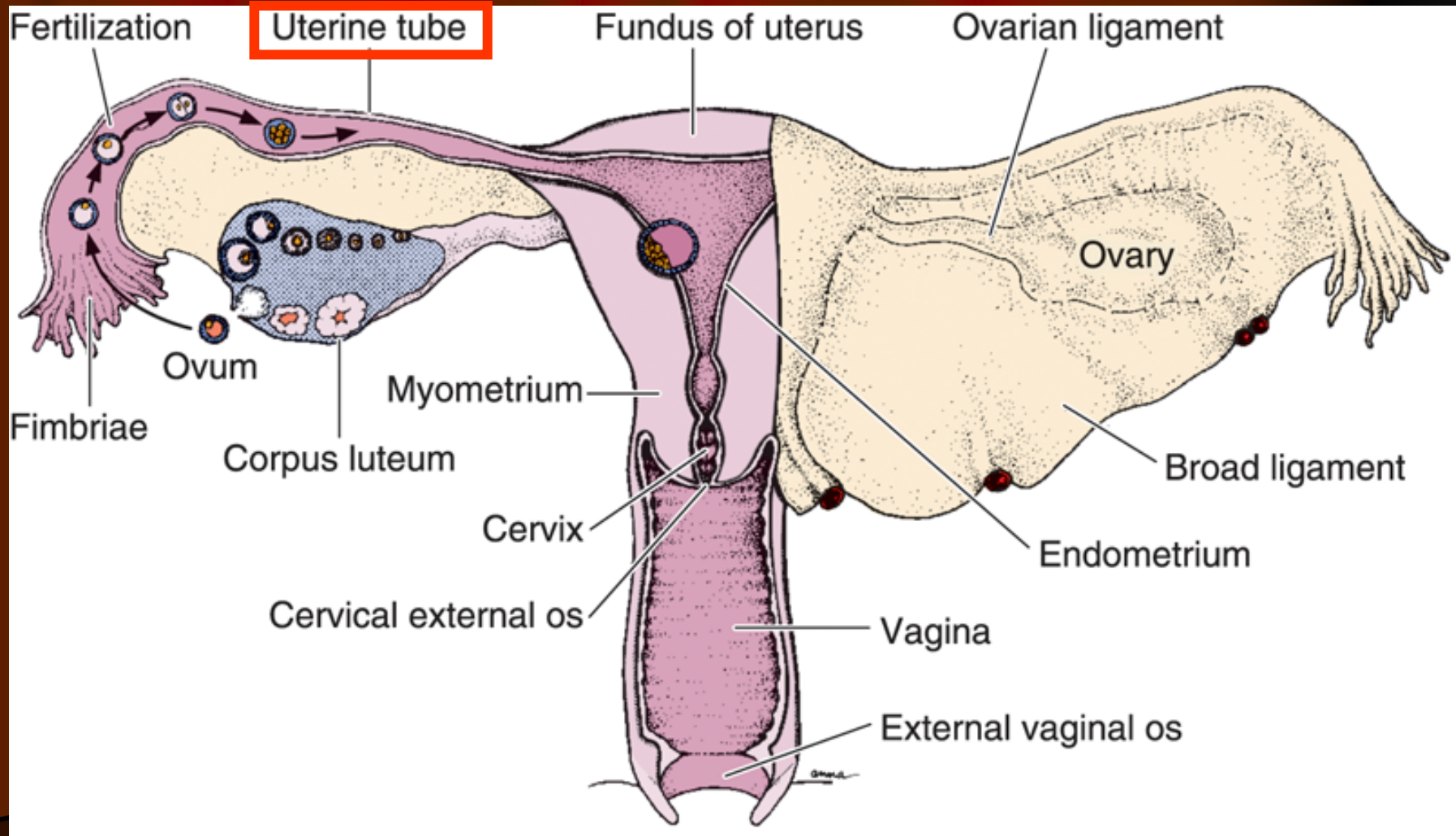
Summary 1.2

- **Only one follicle completes** its maturation and **ovulates one oocyte with** zona pellucida, corona radiata and cumulus cells during each cycle.
- **Most ovarian follicles are lost** by **atresia** mediated by **apoptosis** of granulosa cells at **any stage**, forming **atresic follicle or interstitial glands**.
- **Corpus luteum formed** from the remained granulosa cells and theca cells **after ovulation**.
- **Corpus albicans formed** when corpus luteum degenerate in **14 days** if unfertilized or **6 months** if fertilized.

Summary I - OVARY

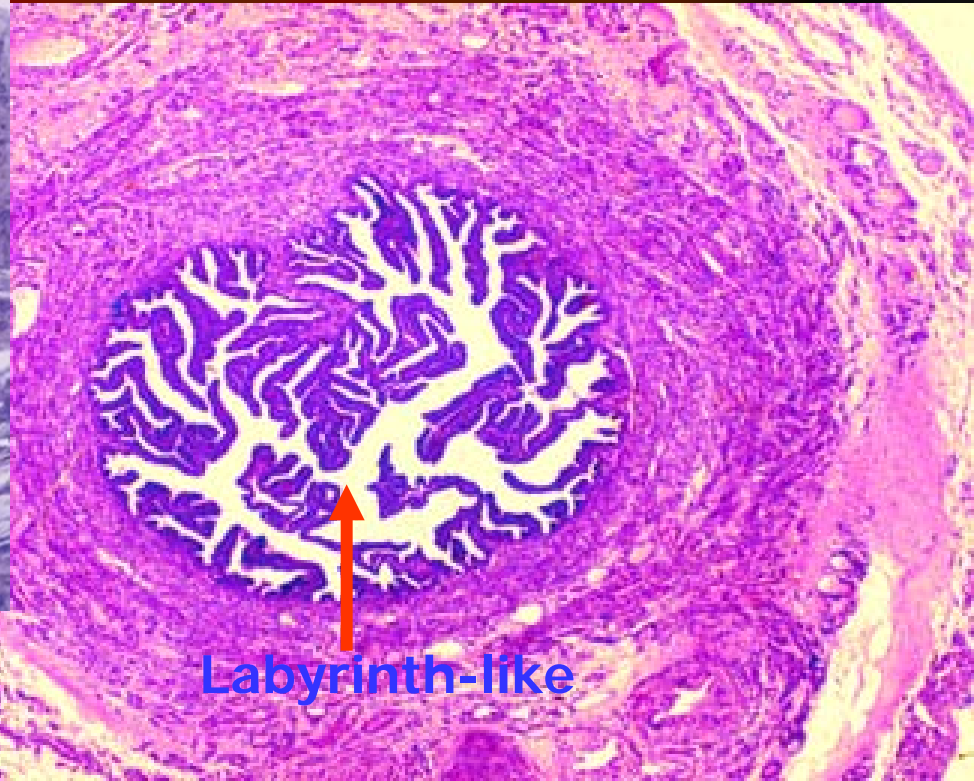
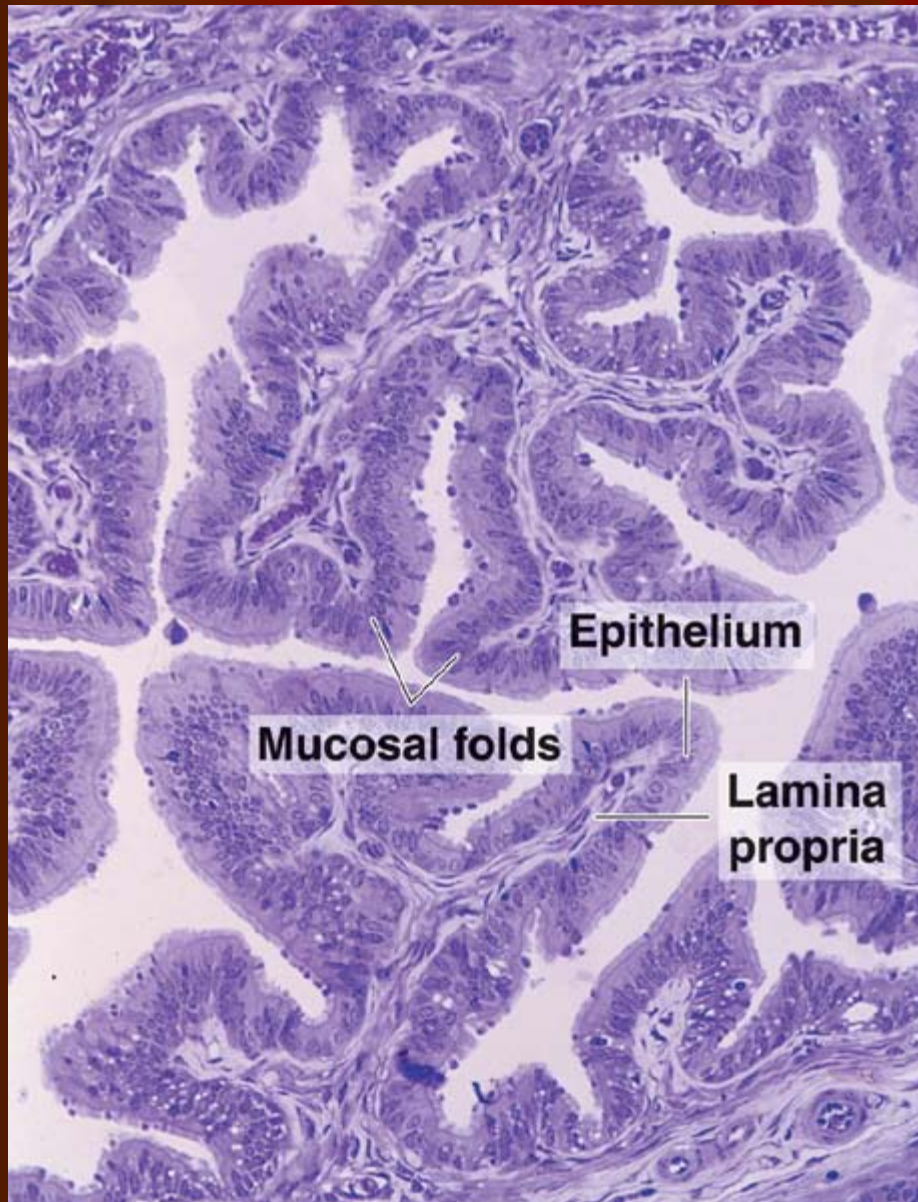
- **Paired** ovary
- **Source** of oocytes
- **Active** at/after puberty
- **Cyclic changes** to produce oocytes
- **Secretion** of estrogen and progesterone
- **Cycle ceases** at menopause, thus no estrogen and progesterone

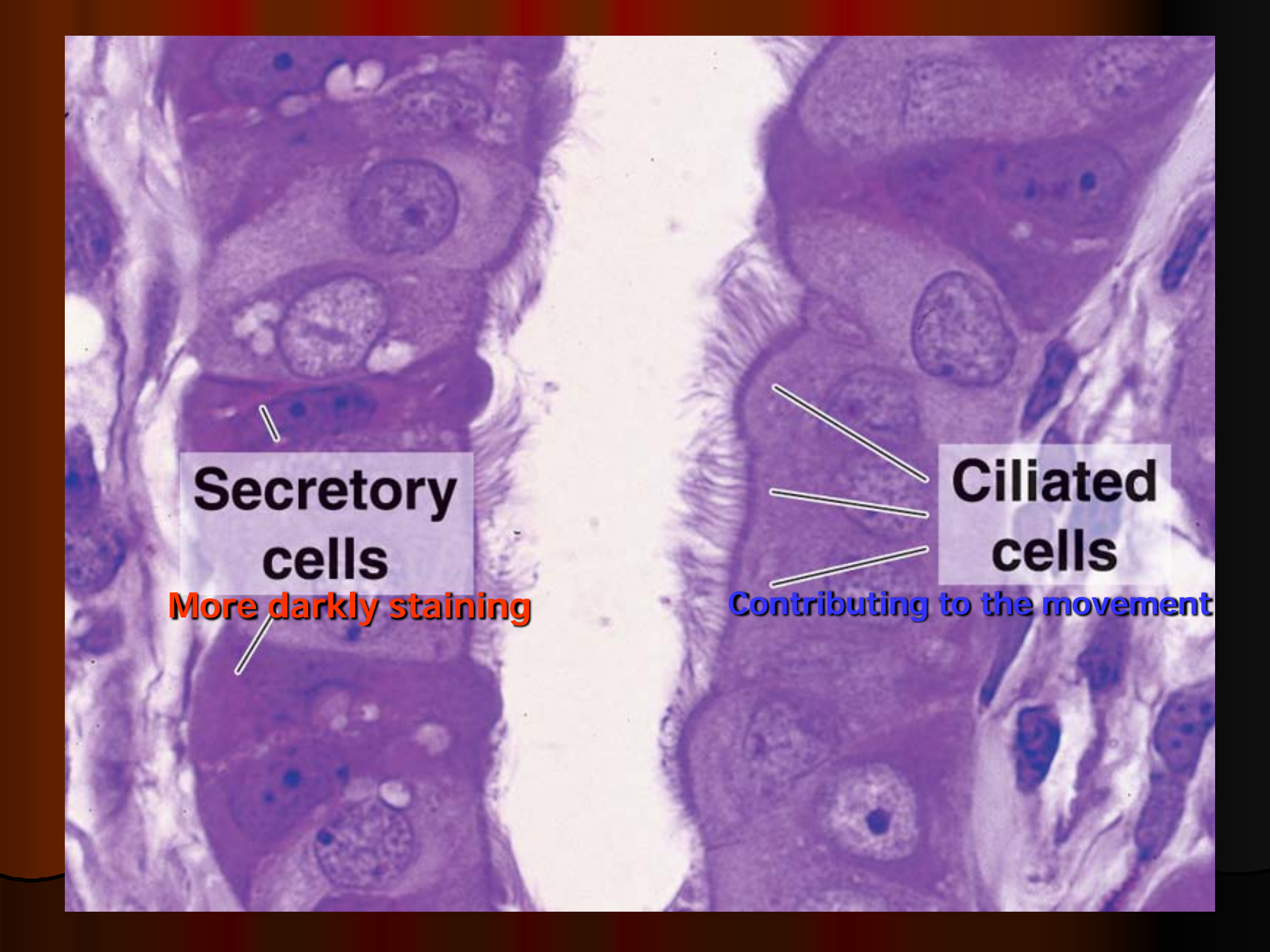
Female Reproductive System



II. Oviduct

- Highly folded mucosa
 - Simple columnar epithelium
 - Ciliated epithelial cells
 - non-ciliated epithelial cells (secretory cells)
 - Lamina propria
- Muscle layers
- Serosa





**Secretory
cells**

This is a light micrograph of a tissue section, likely from the respiratory tract. The image shows two columns of cells. The left column consists of secretory cells, which are stained more darkly. The right column consists of ciliated cells, which have fine, hair-like structures (cilia) extending from their apical surface. The overall structure is columnar and organized into a pseudo-stratified epithelium.

More darkly staining

**Ciliated
cells**

Contributing to the movement

A scanning electron micrograph (SEM) showing a dense field of cilia on a mucosal surface. The cilia are arranged in a regular, parallel pattern. A single cell, identified as a secretory cell, is visible among the ciliated cells, characterized by its distinct shape and the absence of cilia. The overall appearance is that of a highly organized epithelial layer.

Ciliated cell

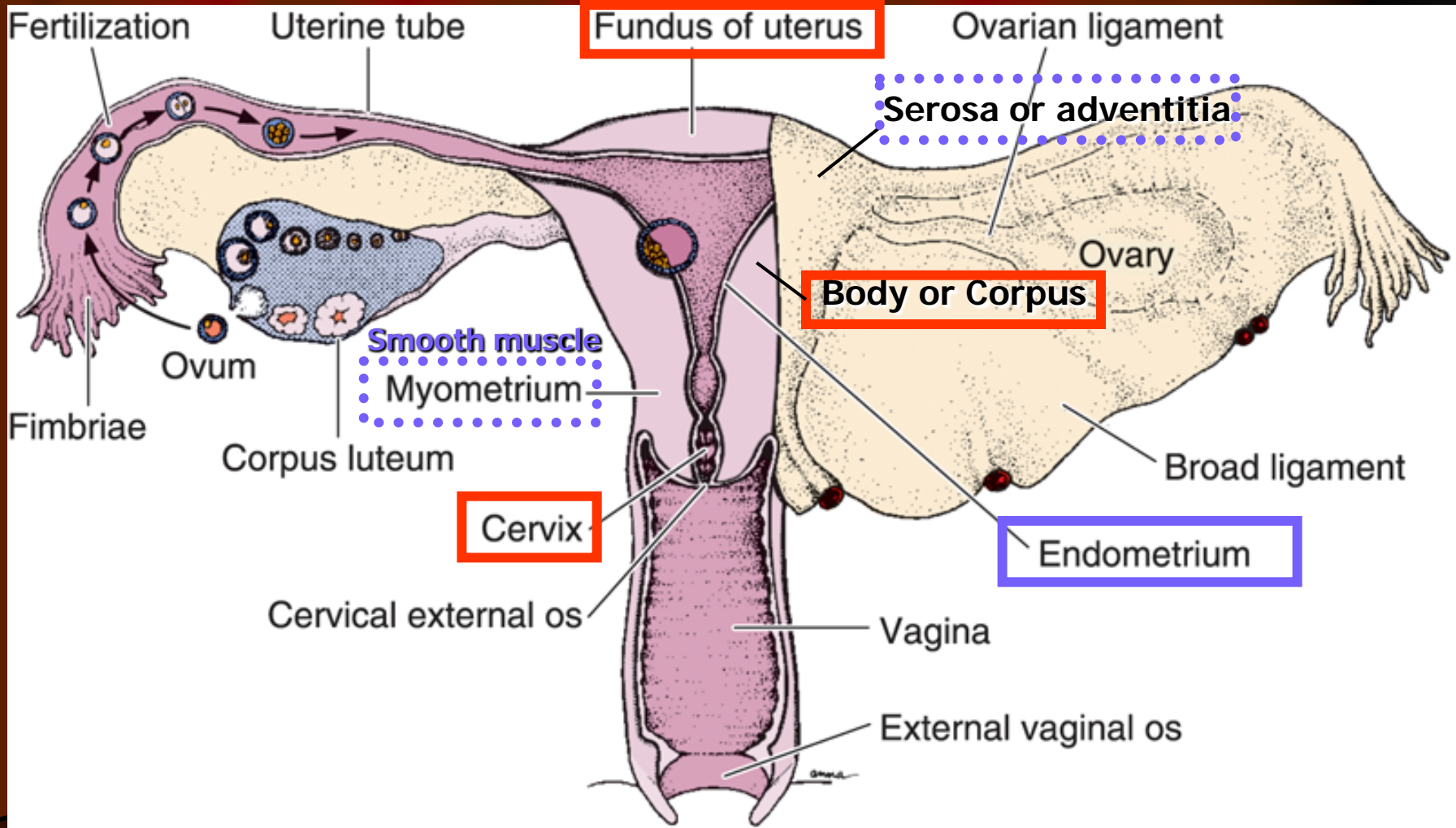
Secretory cell



Summary II - OVIDUCT

- **Fertilization** occurs in uterine tube, ampulla
- **Secondary oocyte complete second meiotic division** to form mature ovum and second polar body if it is penetrated by a sperm
- **Second meiotic division is arrested at metaphase** if it is not penetrated by a spermatozoon

Female Reproductive System



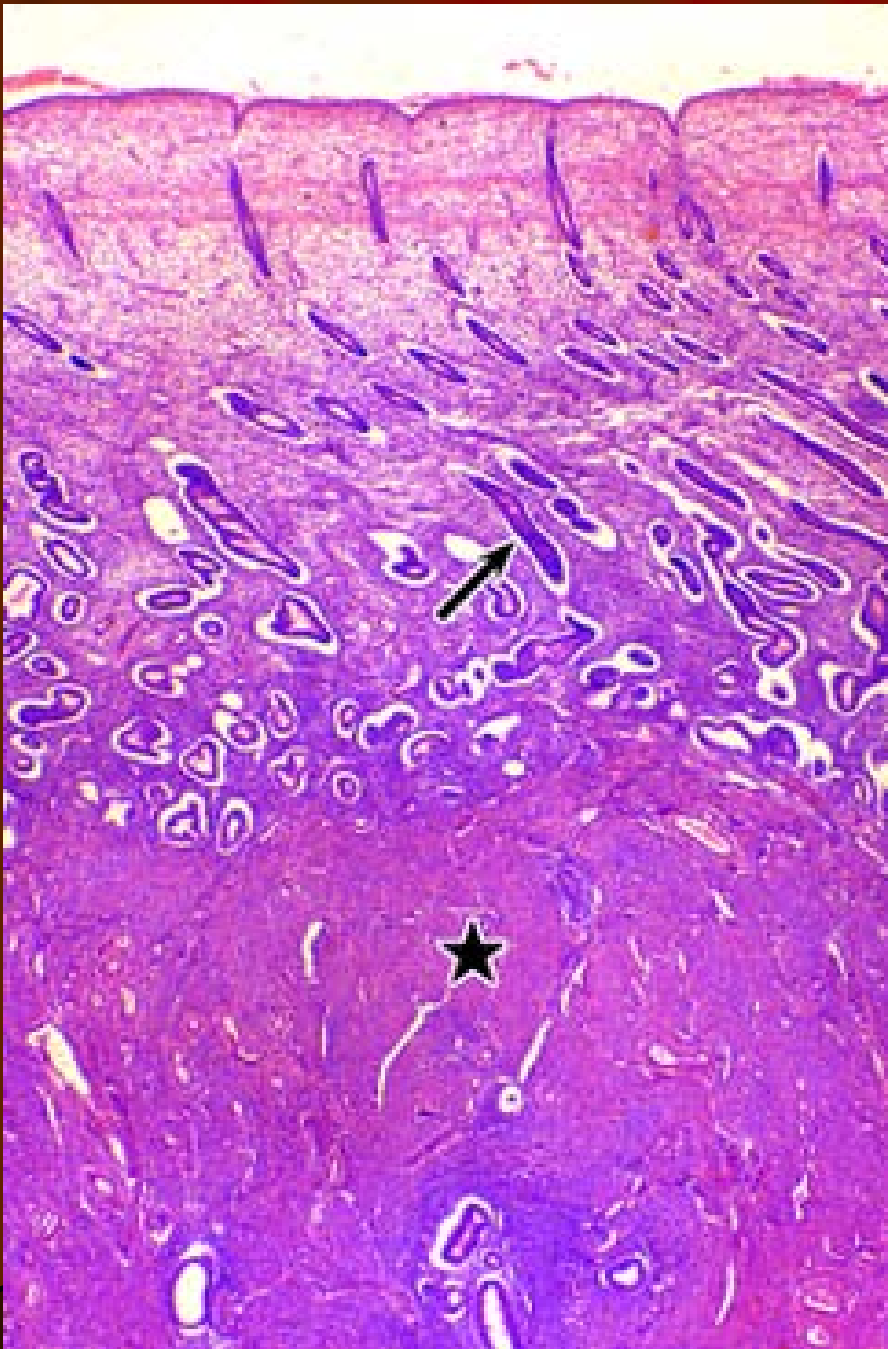
Human Endometrium

- **Epithelium**

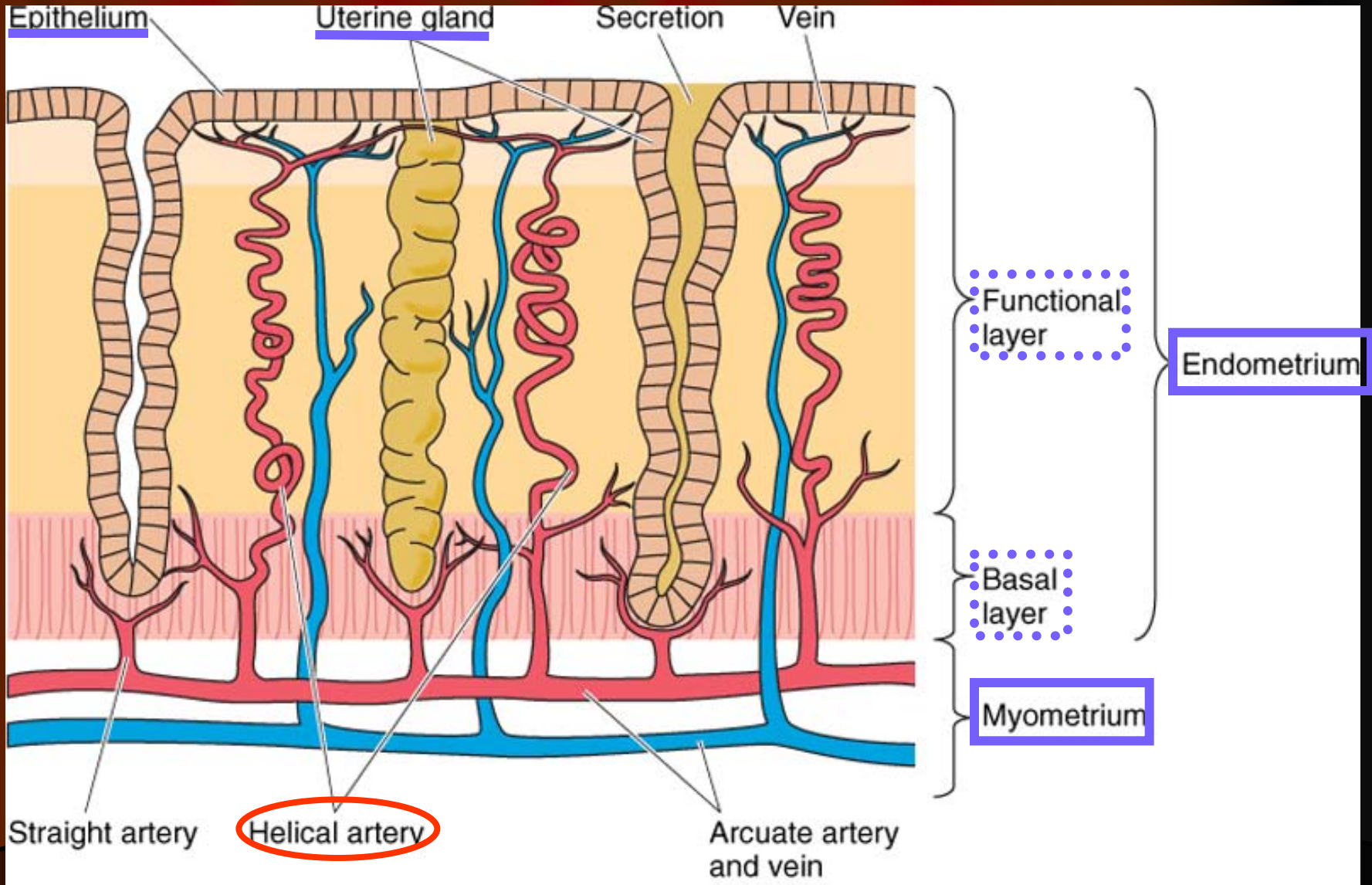
- A mixture of **ciliated** and **secretory** simple columnar cells

- **Lamina propria**

- simple tubular glands (↗)
 - **Similar to the superficial epithelium, but ciliated cells are rare**
- **connective tissue**
 - **rich in fibroblast (stroma cells)**
 - **Contains abundant ground substance**



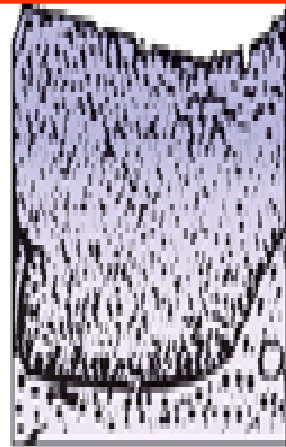
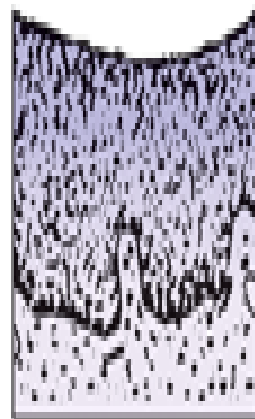
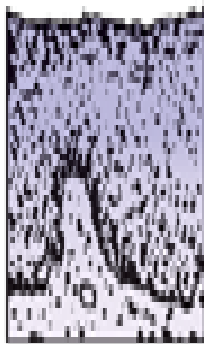
Human Endometrium



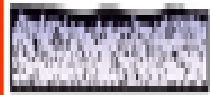
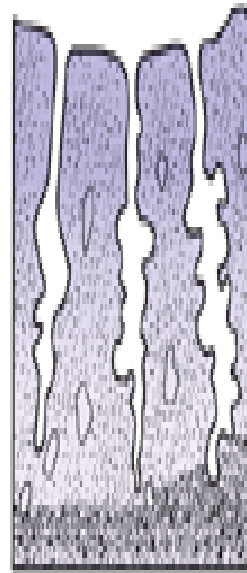
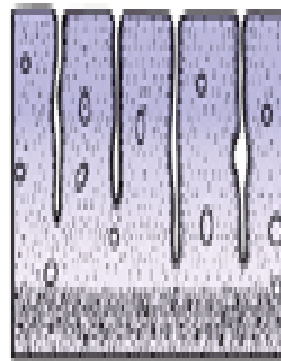
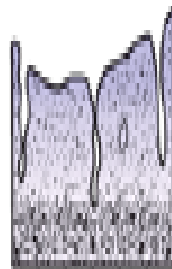
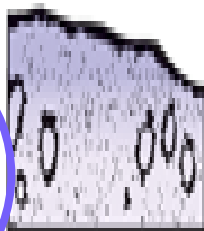
Question 4 & 5

- Elaborate the following contents:
 4. Changes of endometrium during **menstrual cycle**
 5. Endocrine regulation of **ovary** and **uterus**

Vaginal
epithelium



Endometrium



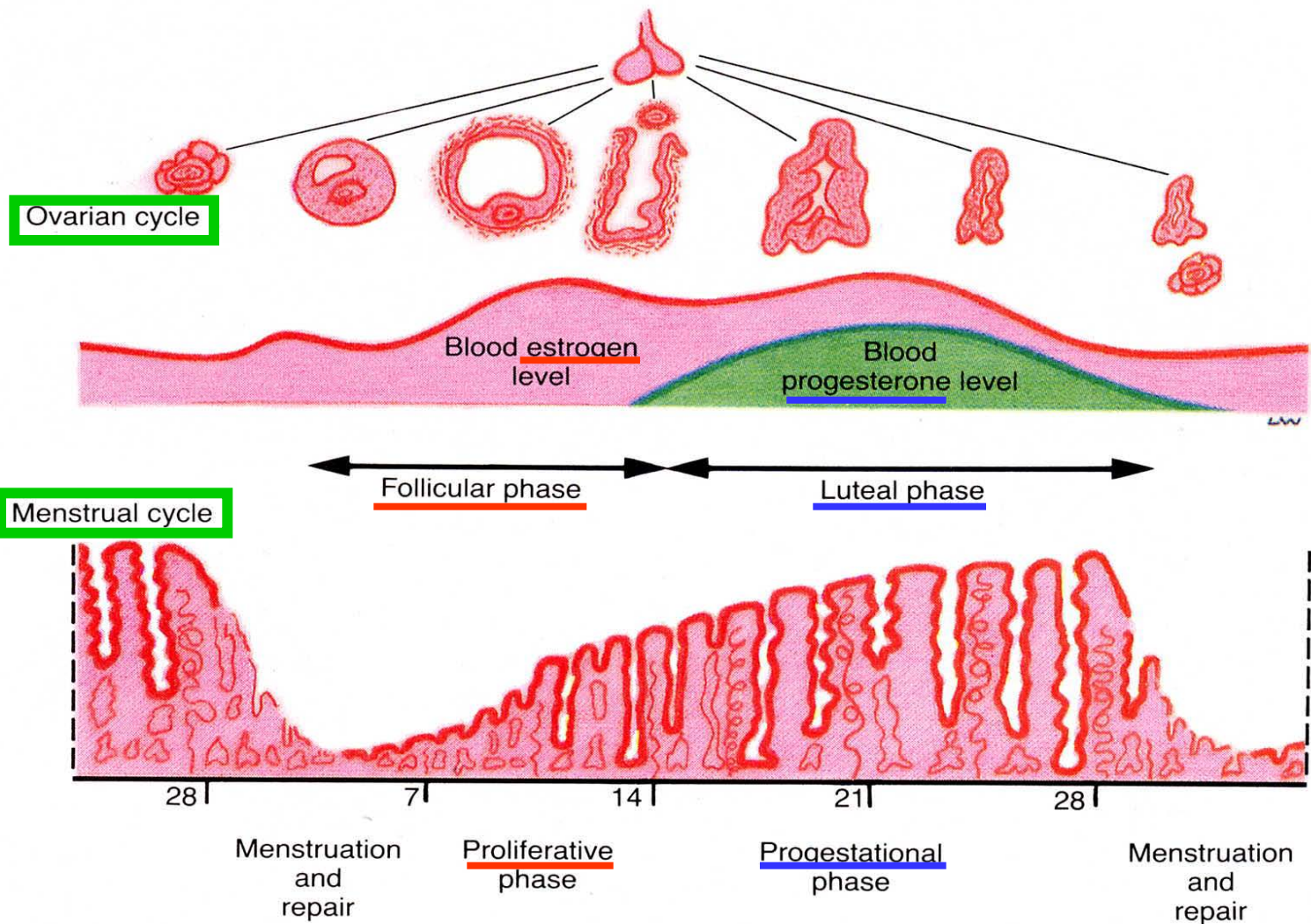
Newborn

Infancy

Menstrual cycle

After menopause

Relationship of Ovarian Cycle and Menstrual Cycle



Menstruation

- Result from a **rapid decline of ovarian hormones**
- **Changes in blood supply** to functional layer
- **Prolonged contraction of spiral arterioles**, each lasting several hours, leading to **ischemic functional layer**
- The process continues for about two days
- **Disruption of surface epithelium, glands and arterioles in functional layer**
- **Sloughing of tissues** from functional layer, vaginal discharge
- **Only the basal layer** of endometrium remains intact

Endometrium - Proliferative



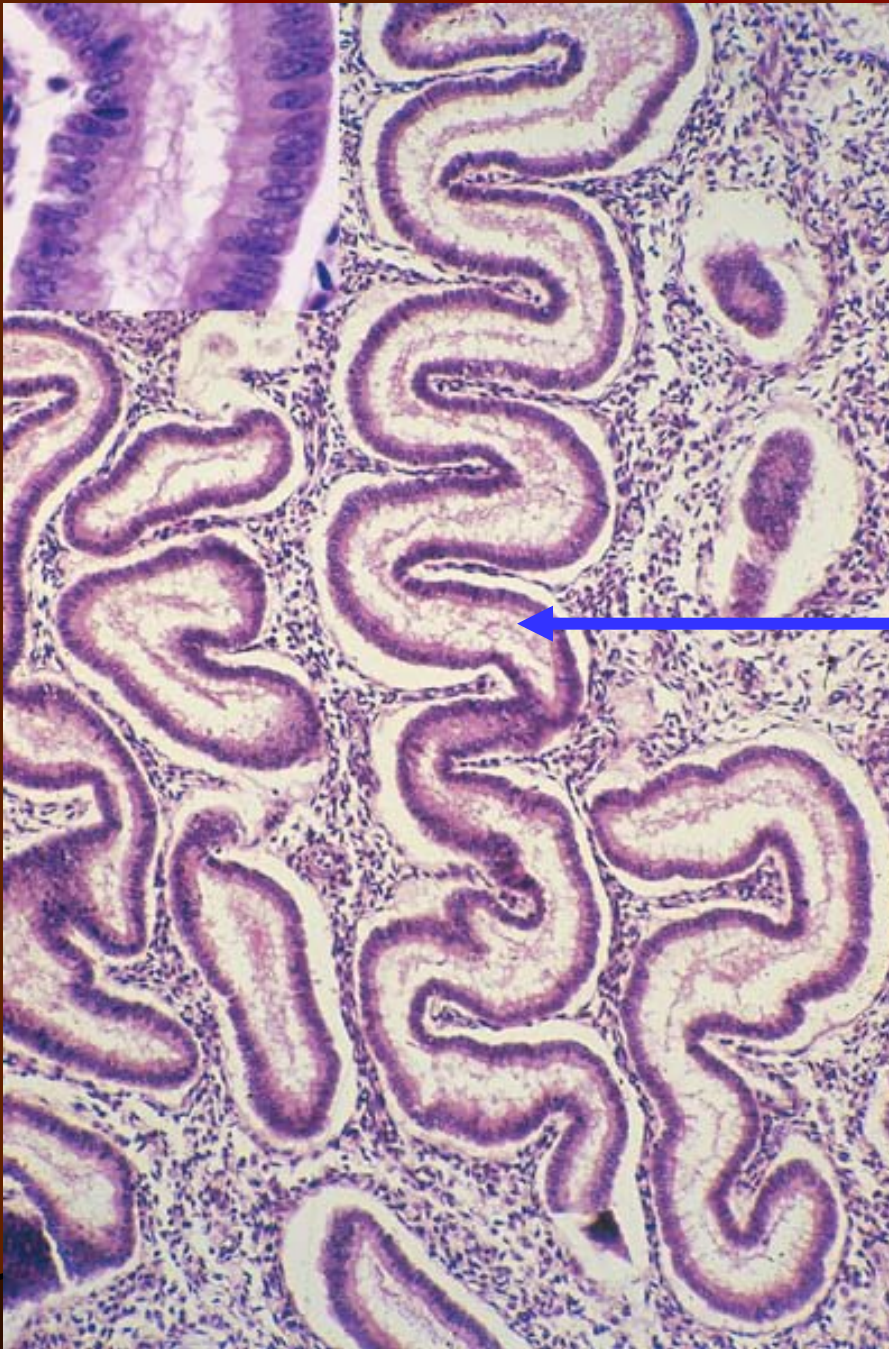
Straight tubule
Narrow lumen
Endometrial
glands

Stroma

2-3 mm thick Functional layer

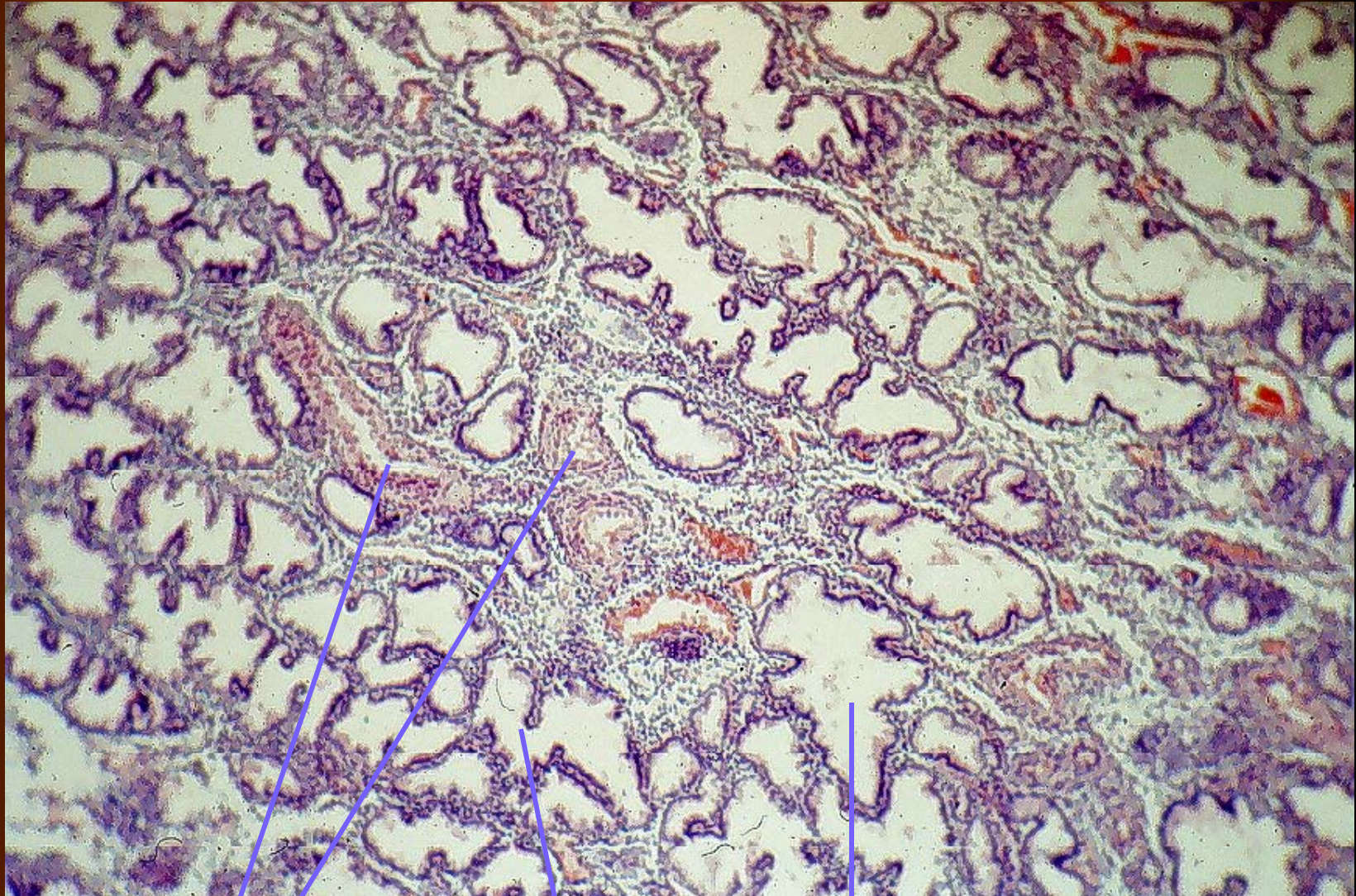
Basal layer

Endometrium (secretory phase)



- Extensively coiled arterioles
- Very thick functional layer with highly convoluted glands
- Stroma becomes edematous
- Early secretory phase
 - vacuolar BELOW their nuclei of gland cells
- Late secretory phase
 - vacuolar ABOVE their nuclei of gland cells

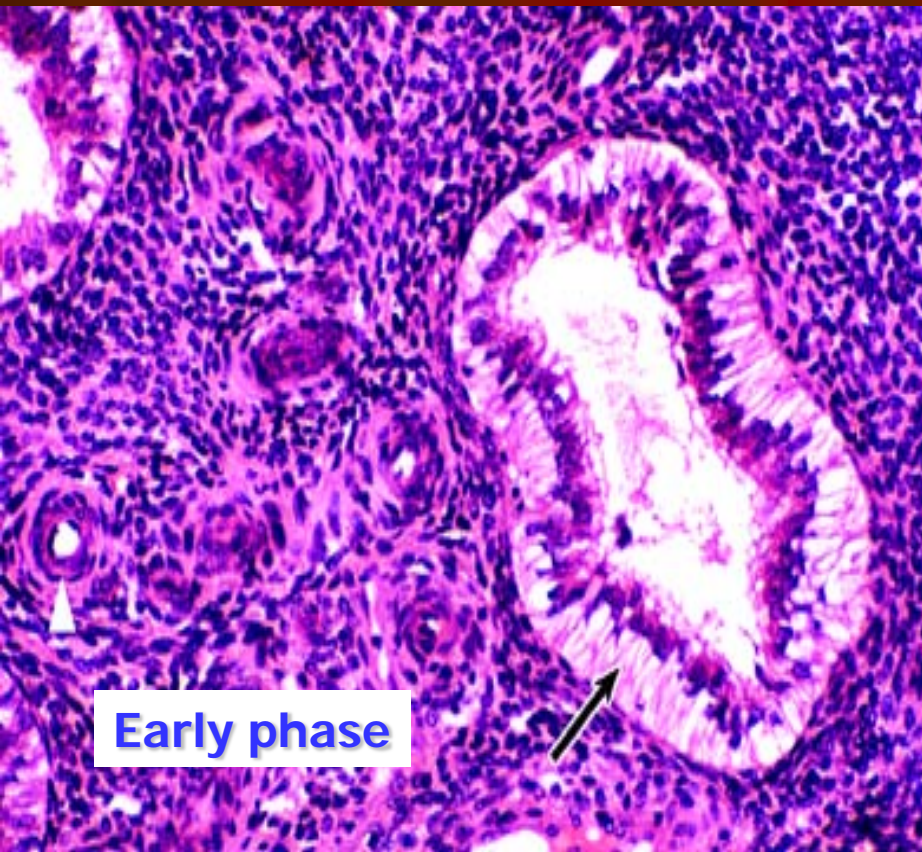
Endometrium - Secretory



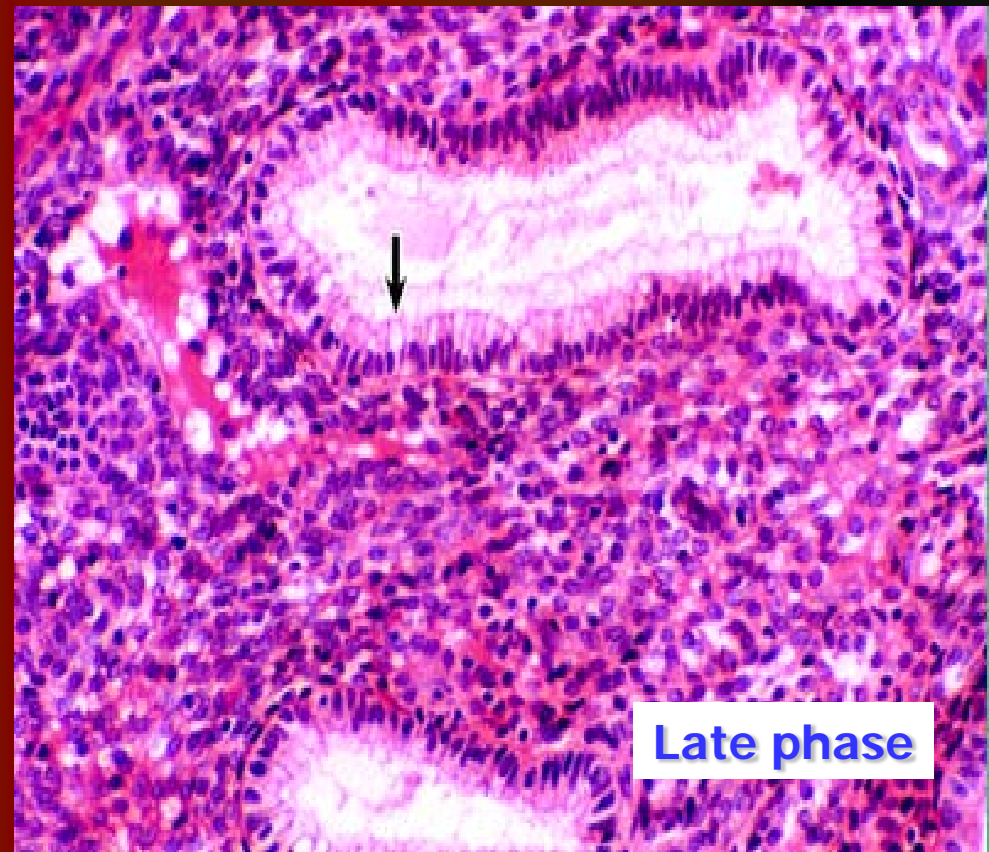
Arteriole (coiled)

Endometrial glands (convoluted)

Human Endometrium (Secretory or Luteal Phase)



Early phase

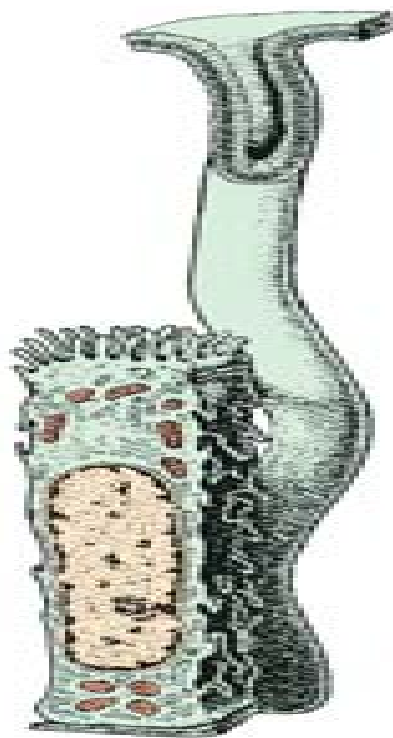


Late phase

Uterine gland with vacuolar **BELOW** or **ABOVE** their nuclei of gland cells
Stroma cell → predecidual cell

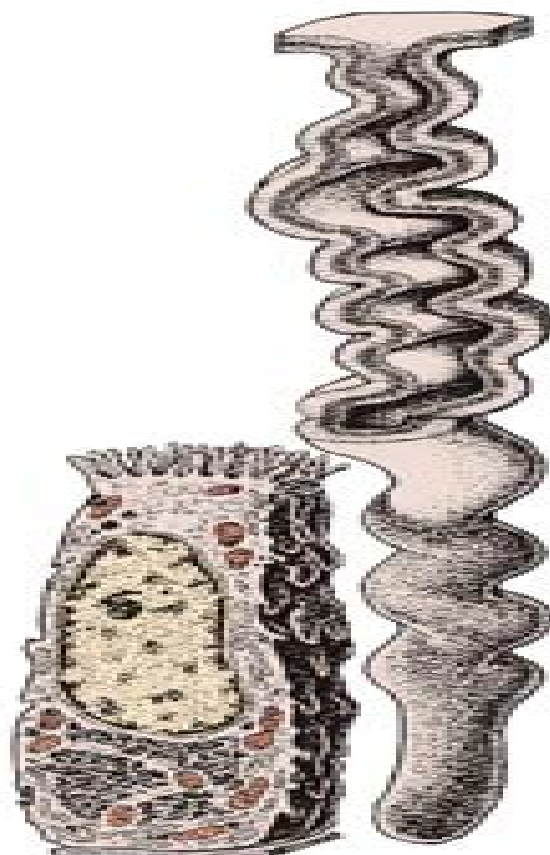
Changes in the Uterine Glands and in the Gland Cells During Menstrual Cycle

0.5 mm



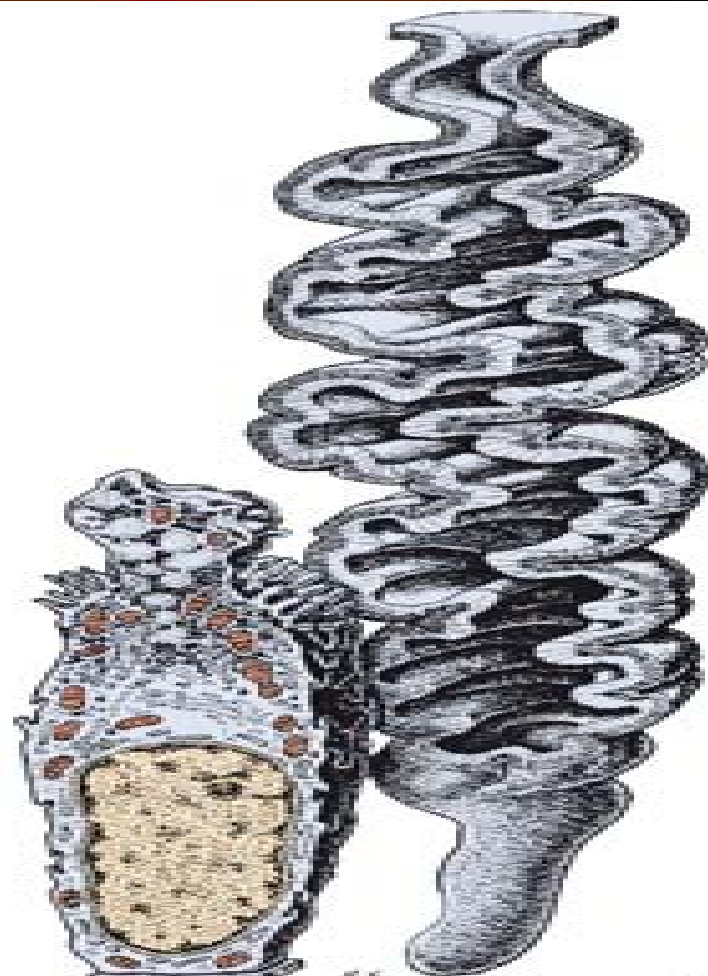
End of proliferative phase

Day 14



Initial secretory phase

Days 15-21



Late secretory phase

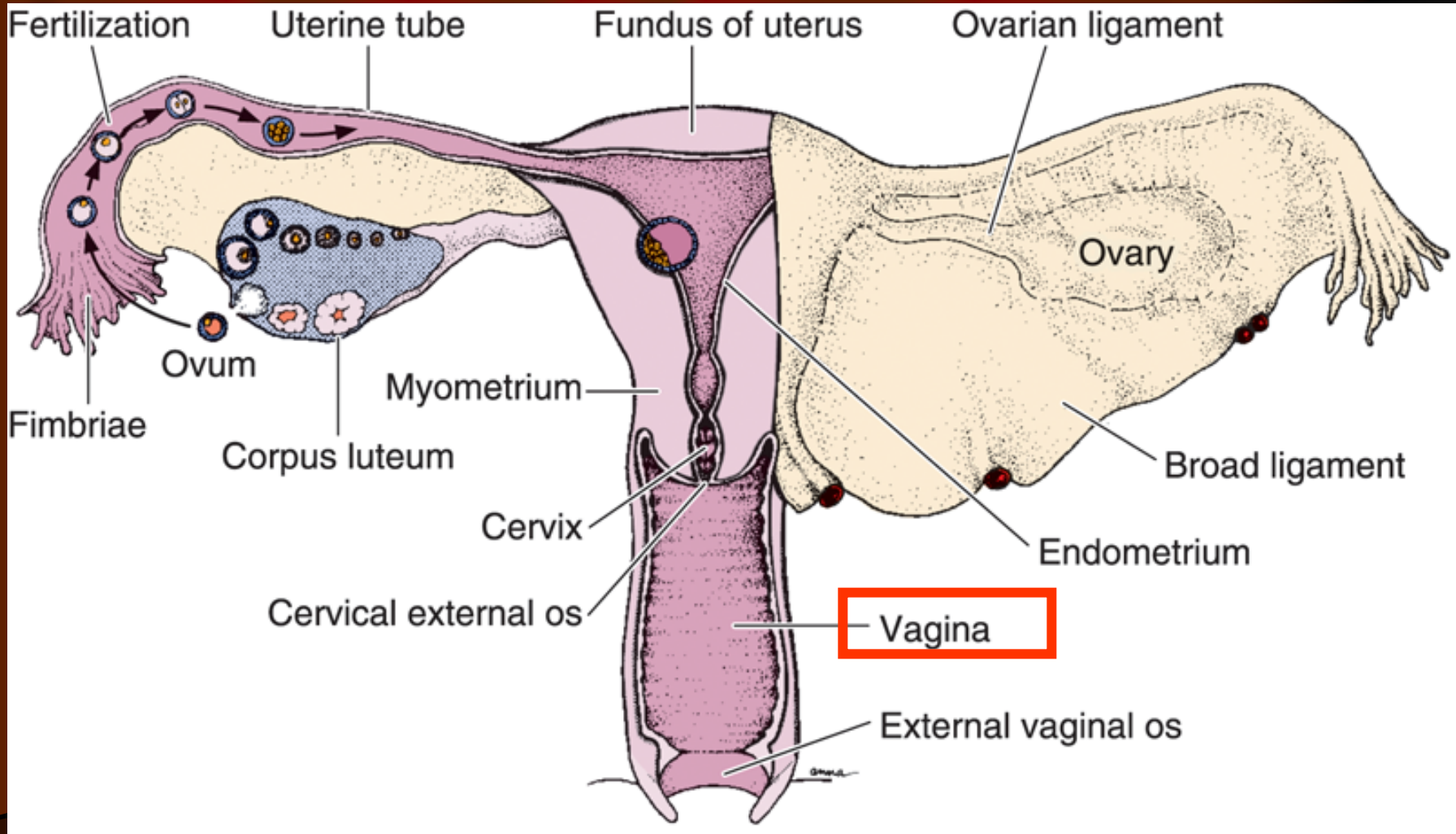
Days 22-28

5 μ m

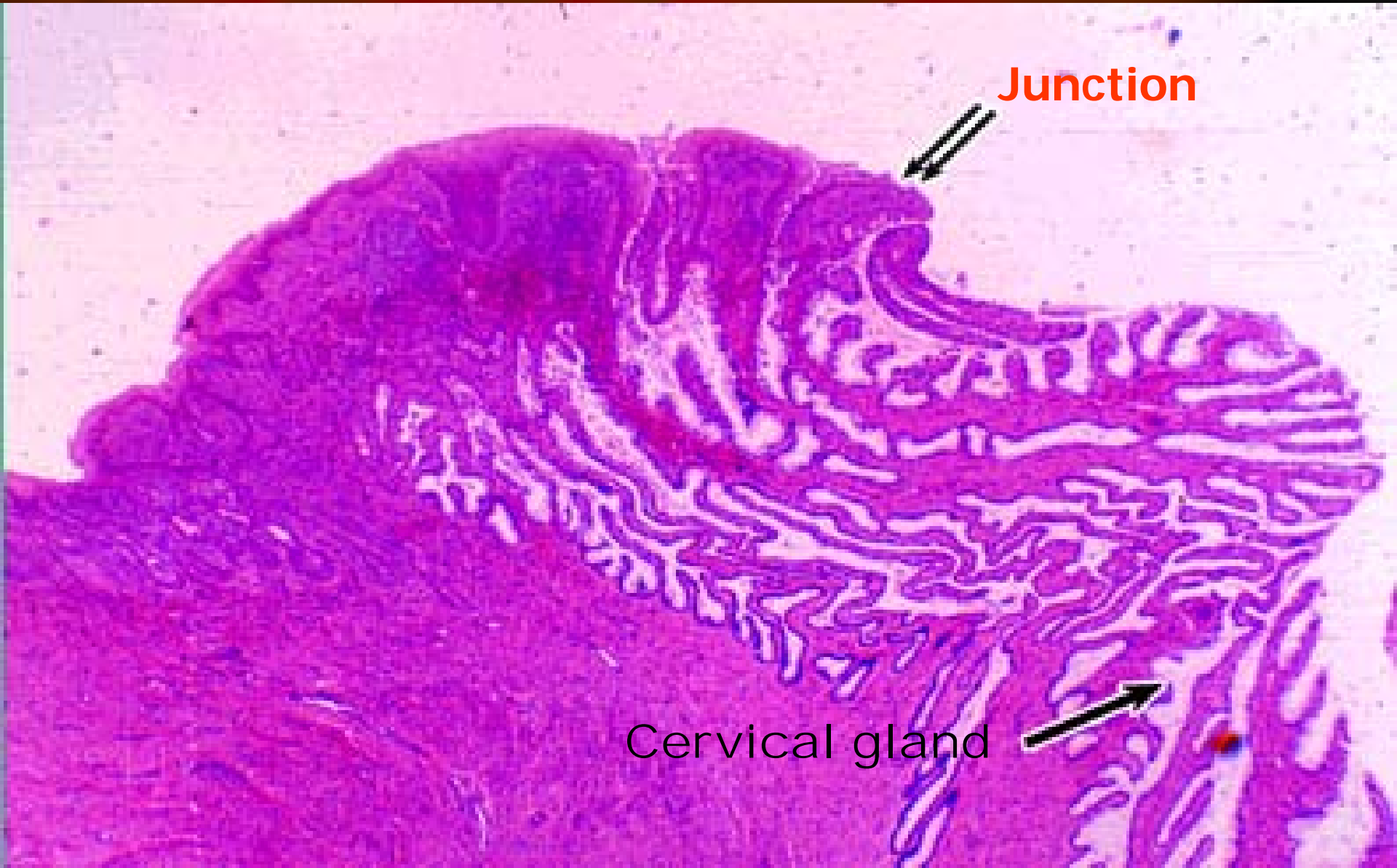
Summary III - UTERUS

- The **myometrium** forms a structural and functional syncytium
- The endometrium proliferates and degenerates during a menstrual cycle, **mainly in**
 - The stratum functional or **functional layer**
 - The **vasculature** also
- **Cyclic changes** are presented by
 - The proliferative phase
 - Regulated by **Estrogen**
 - The secretory phase
 - Regulated by **Progesterone**
 - The menstrual phase
 - Results from **a decline in the ovarian secretion of P and E**

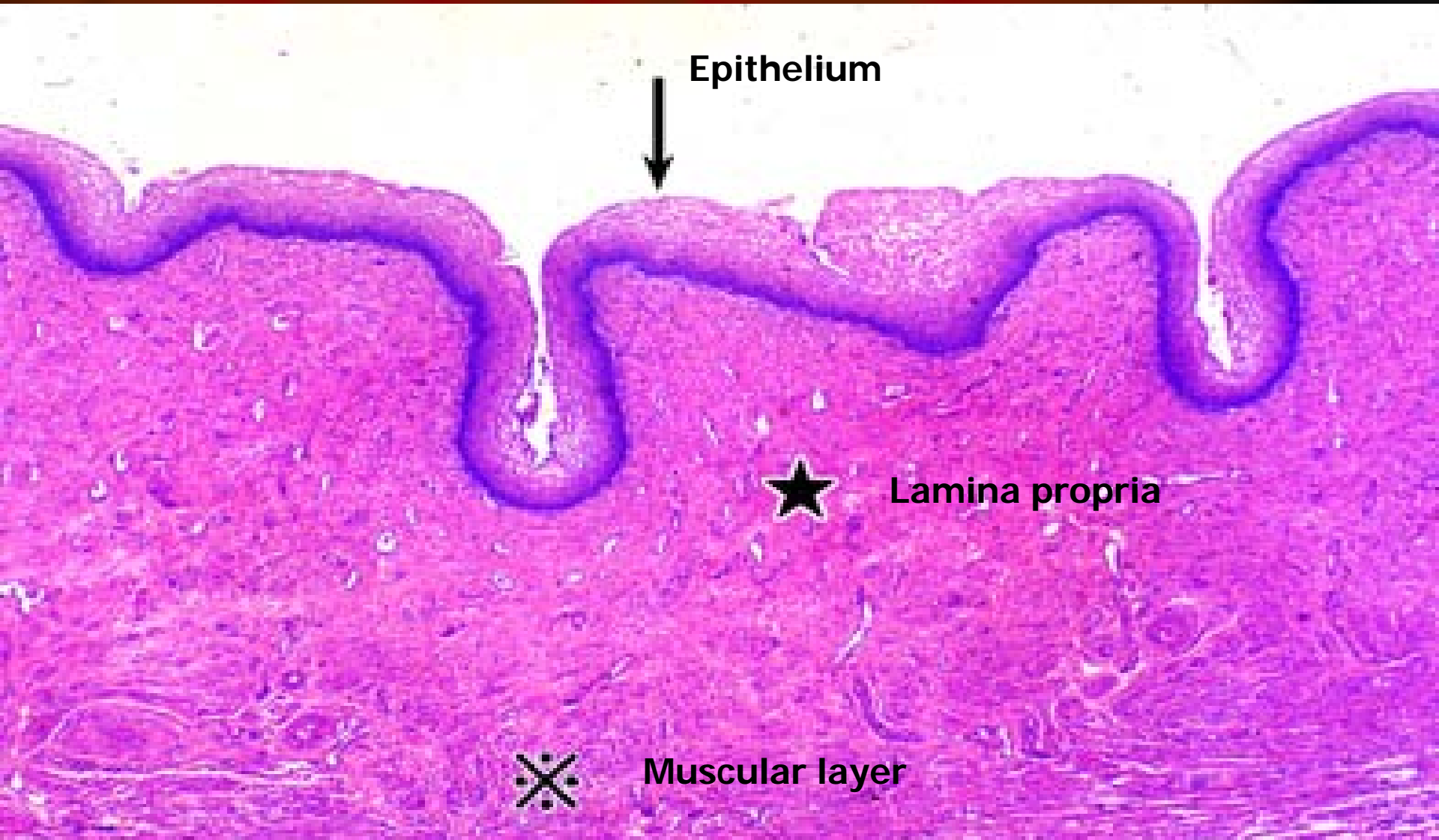
Female Reproductive System



Junction of Human Cervix and Vagina



Human Vagina

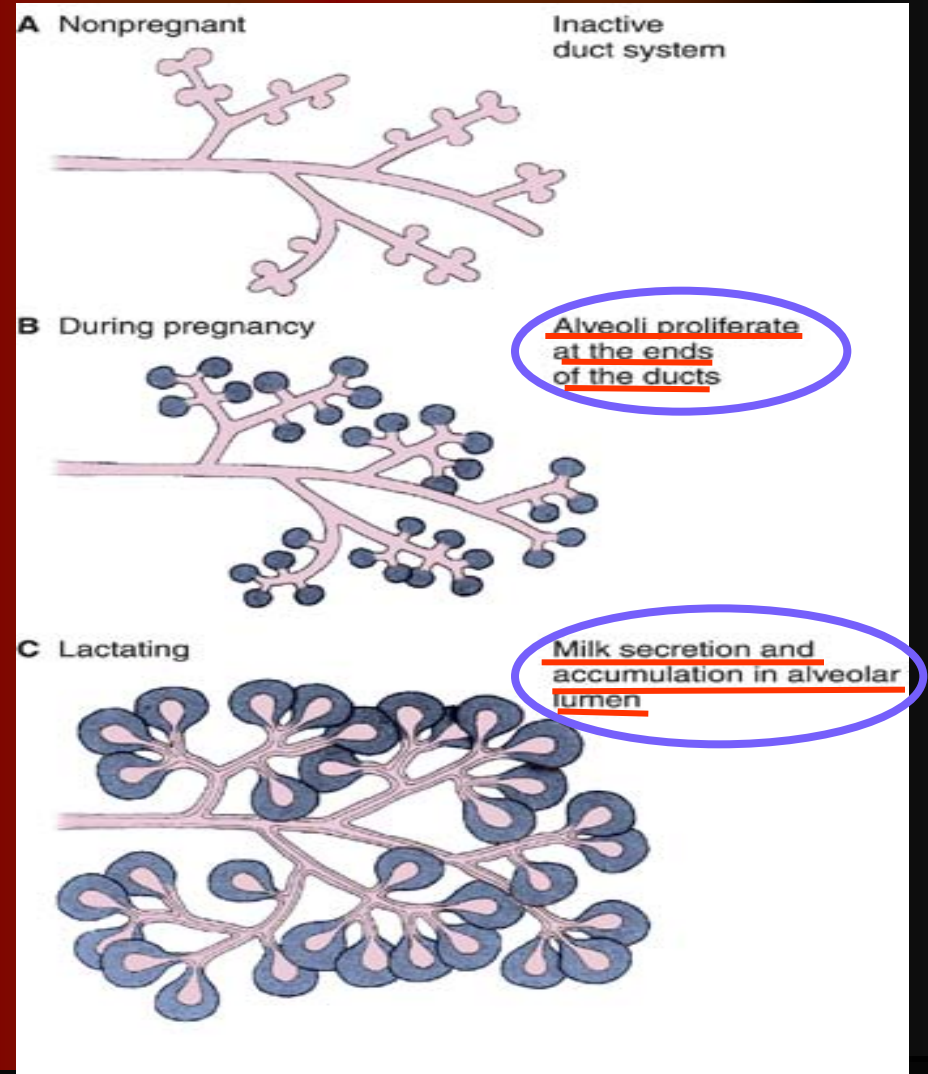
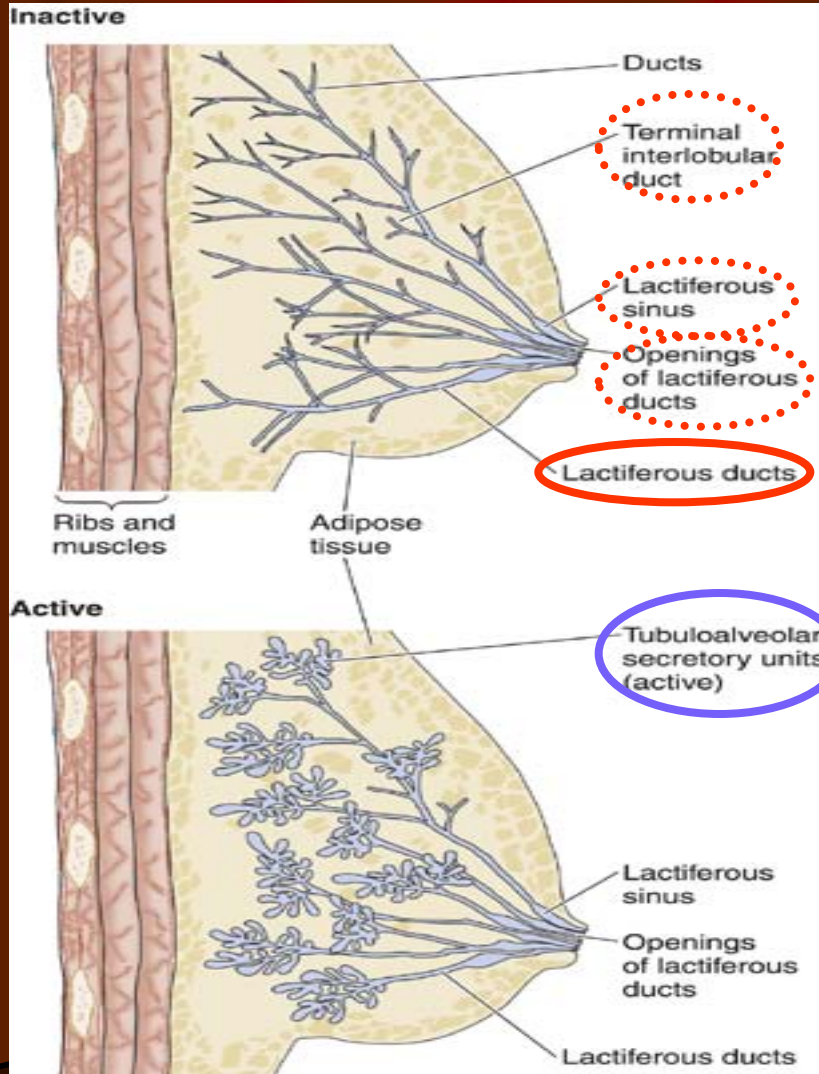


Vagina



- **Mucosa**
 - Stratified squamous
 - typical vacuolated epithelial cells
 - Containing glycogen synthesized and accumulated under the stimulus of estrogen
 - Lamina propria
 - Loose connective tissue rich in elastic fibers
- **Muscular layer**
 - Smooth muscle
 - Innermost: circular
 - The outer: longitudinal mainly
- **Adventitia**
 - Dense connective tissue rich in thick elastic fibers

Mammary Glands



Mammary Glands

INACTIVE BREAST

Adipose tissue

Lactiferous duct system

Lactiferous sinus

Opening of sinus

LACTATING BREAST

Adipose tissue

Enlarged secretory lobules

Elaborate duct system

Myoepithelial cell

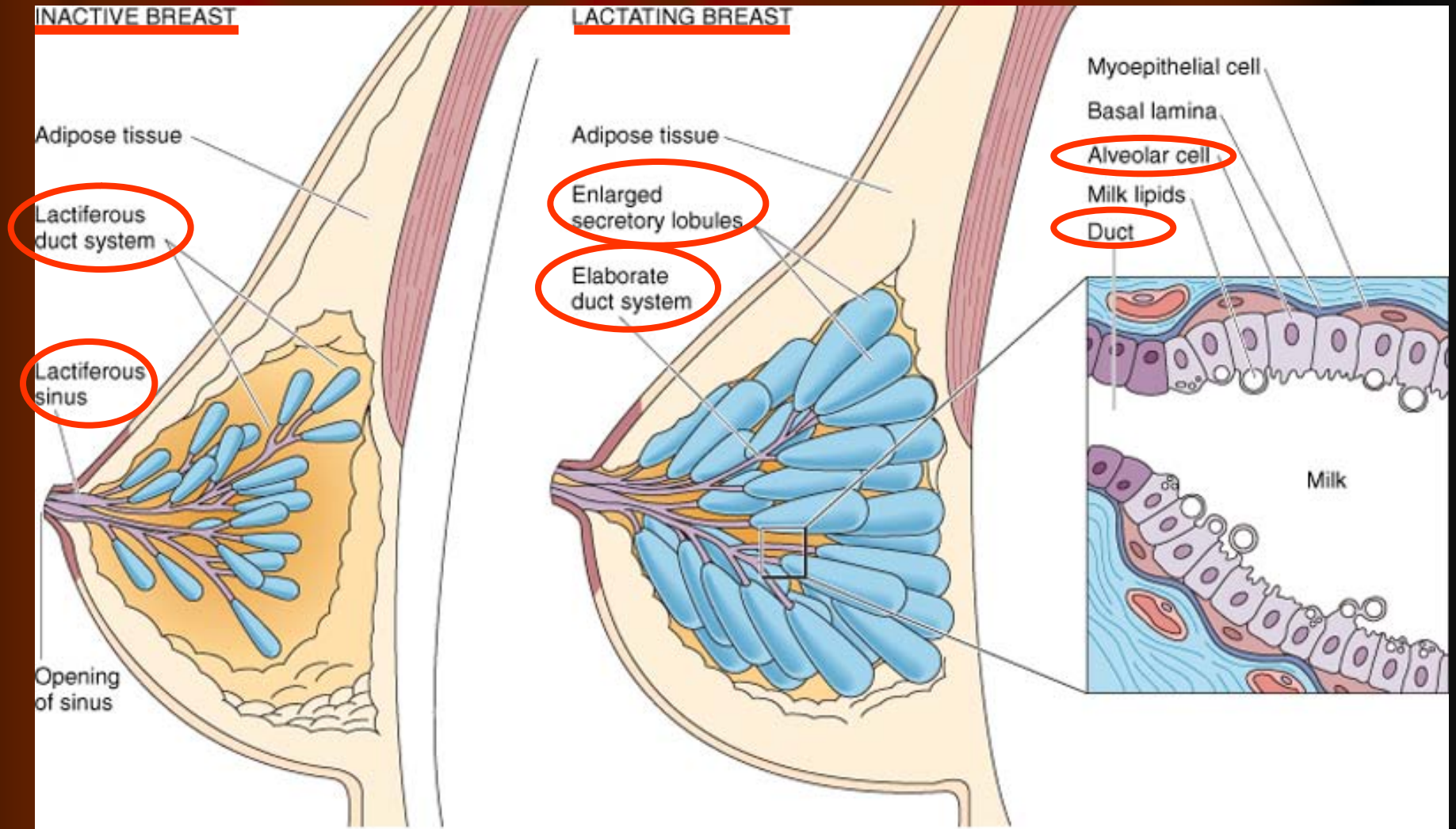
Basal lamina

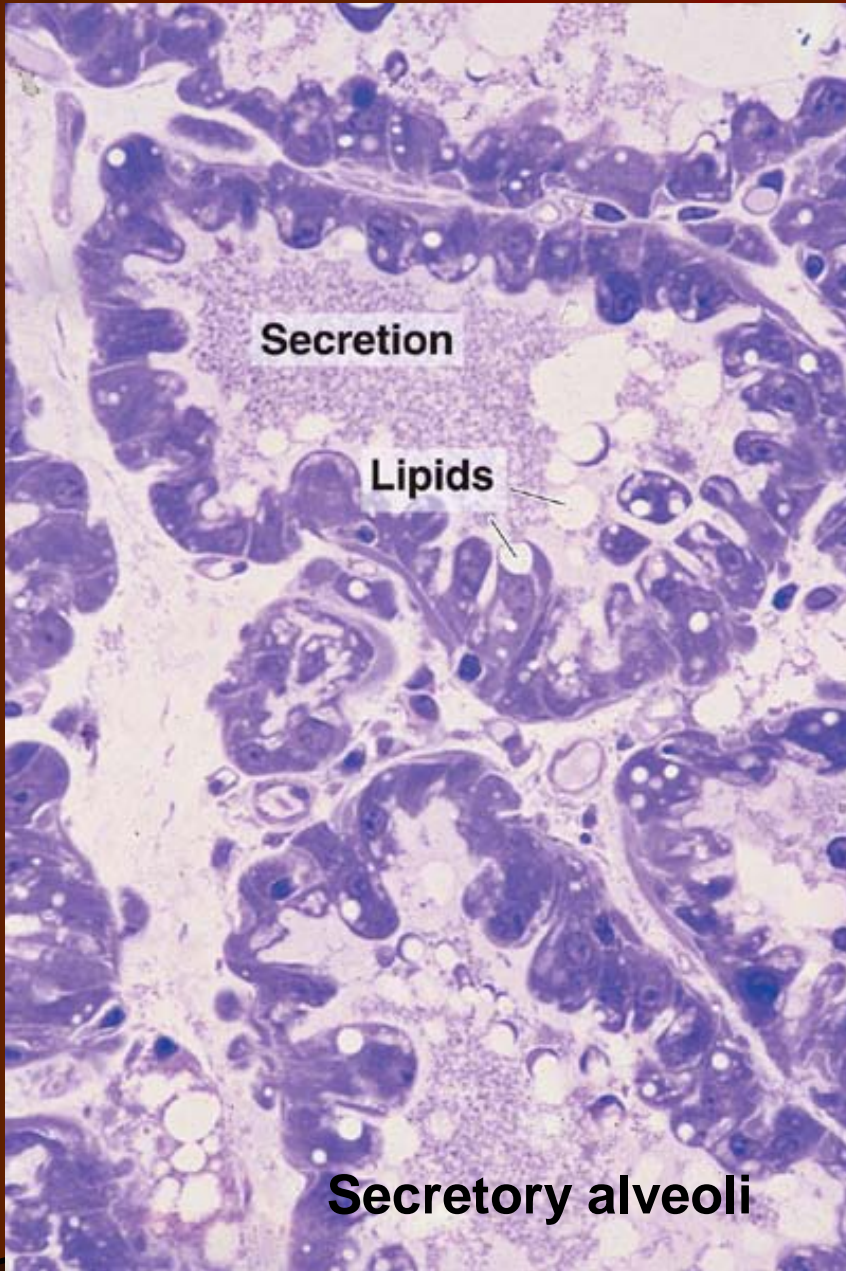
Alveolar cell

Milk lipids

Duct

Milk

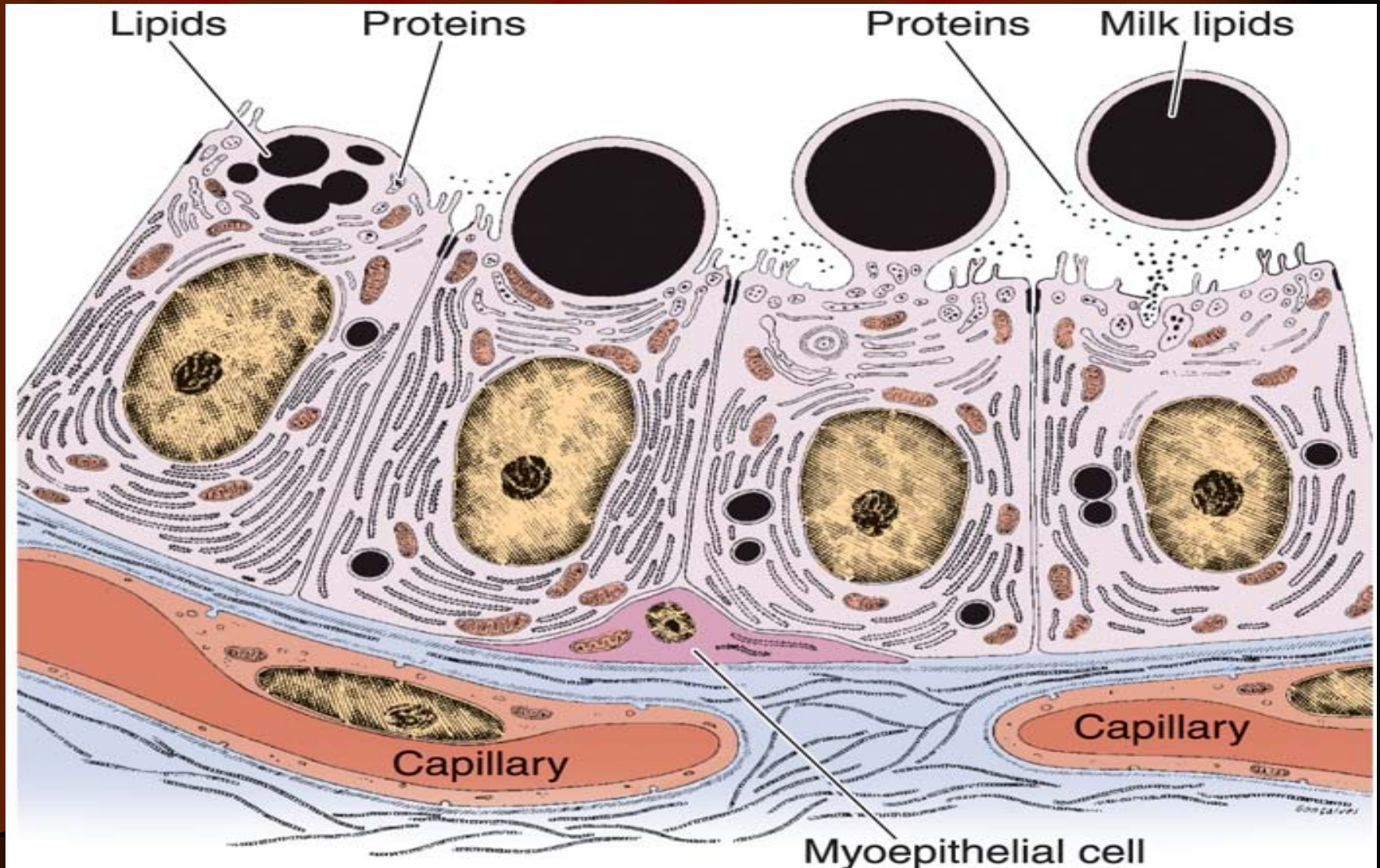




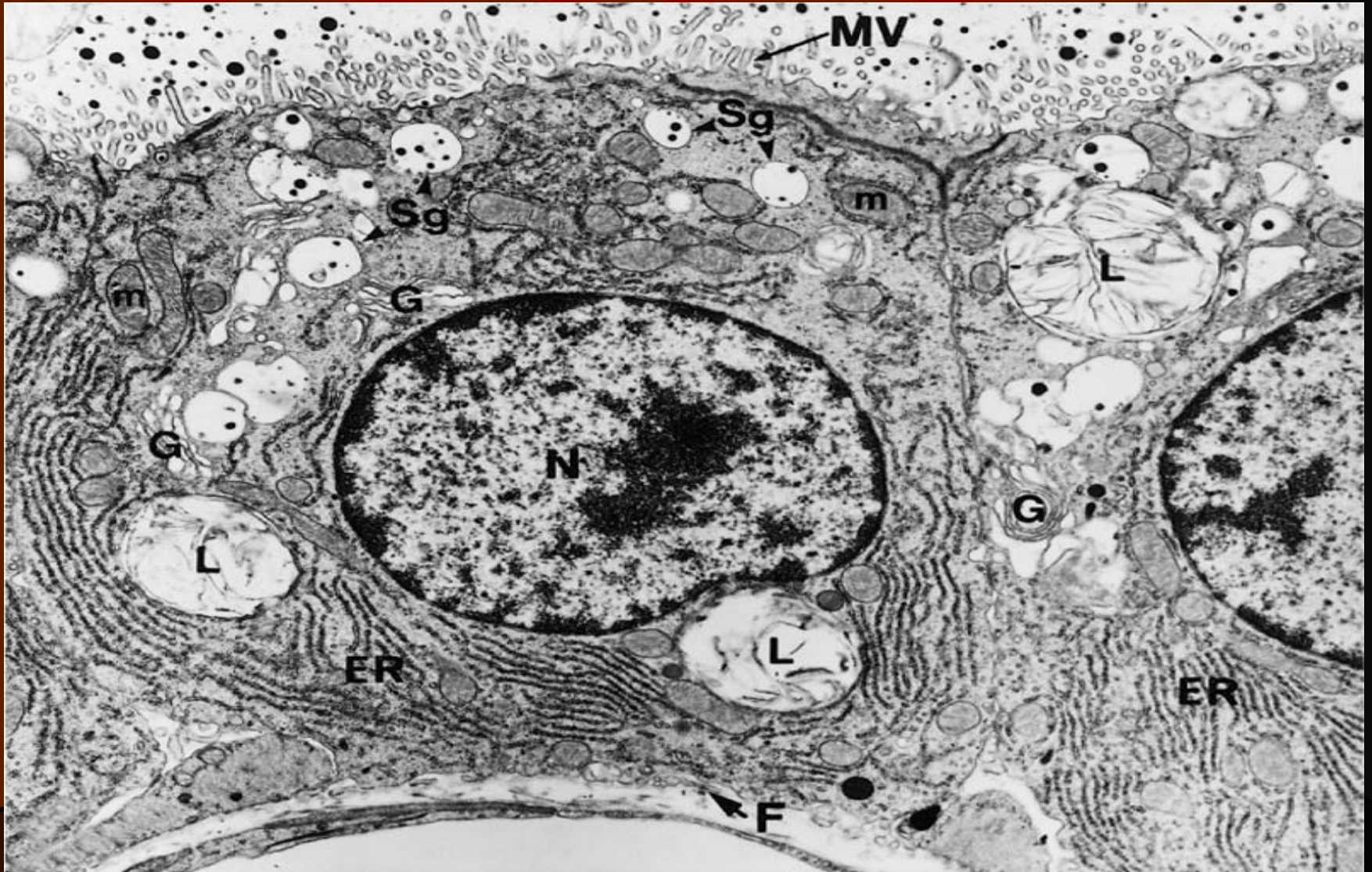
Lactating Mammary Gland

- Secretory alveoli
 - Filled with milk
 - Visible as granular material
 - Containing
 - Protein: merocrine
 - Fatty component: apocrine
 - Shown as vacuoles in the alveolar cell cytoplasm and in the lumen

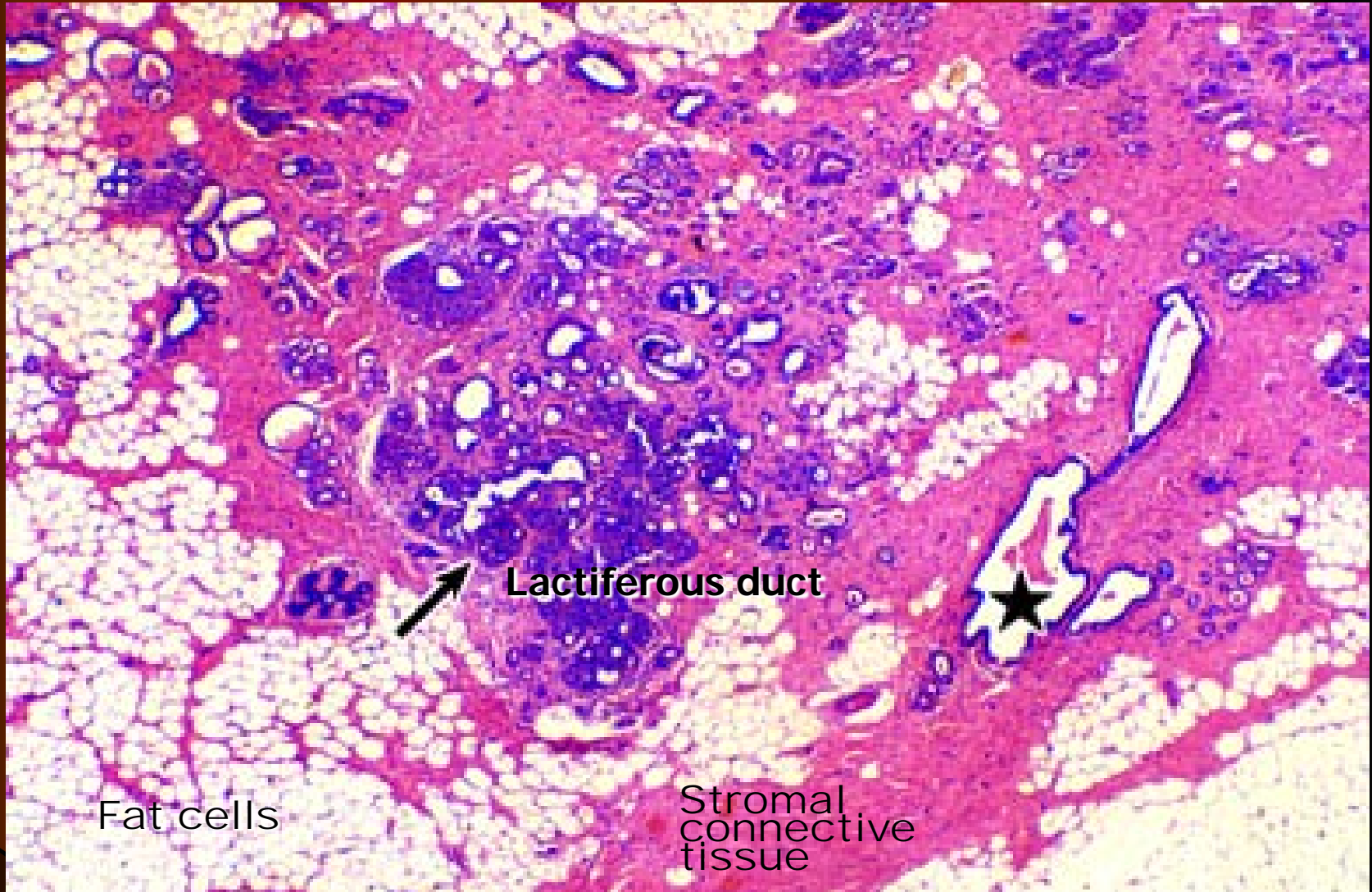
Secreting Cells from the Mammary Gland



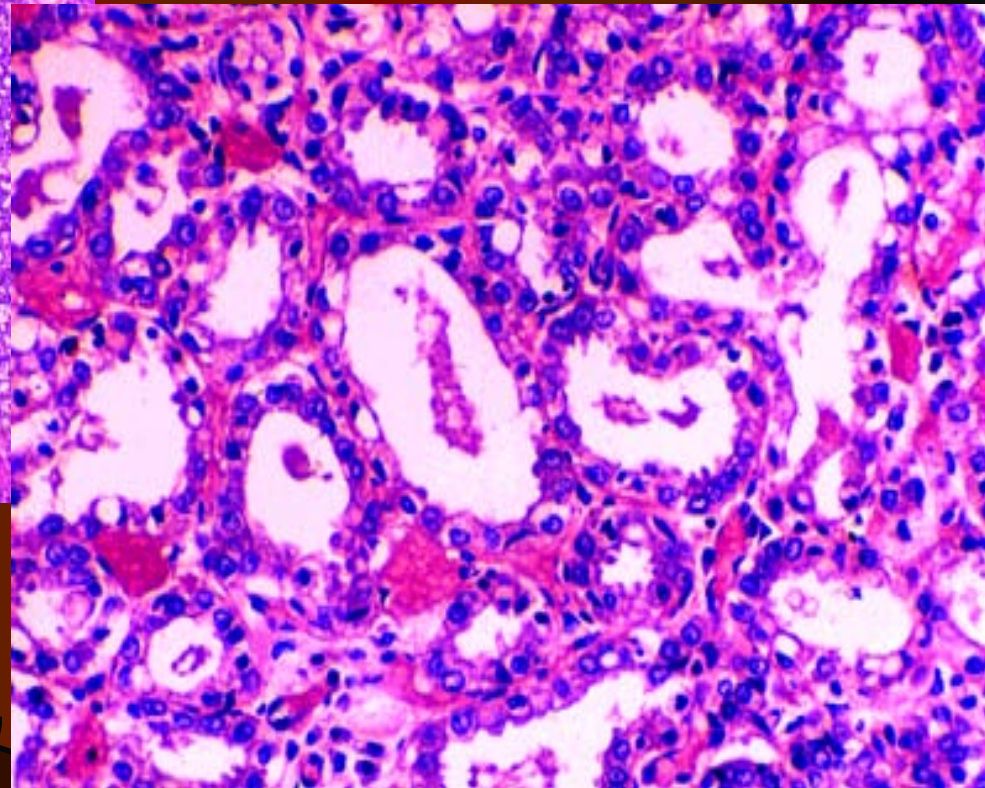
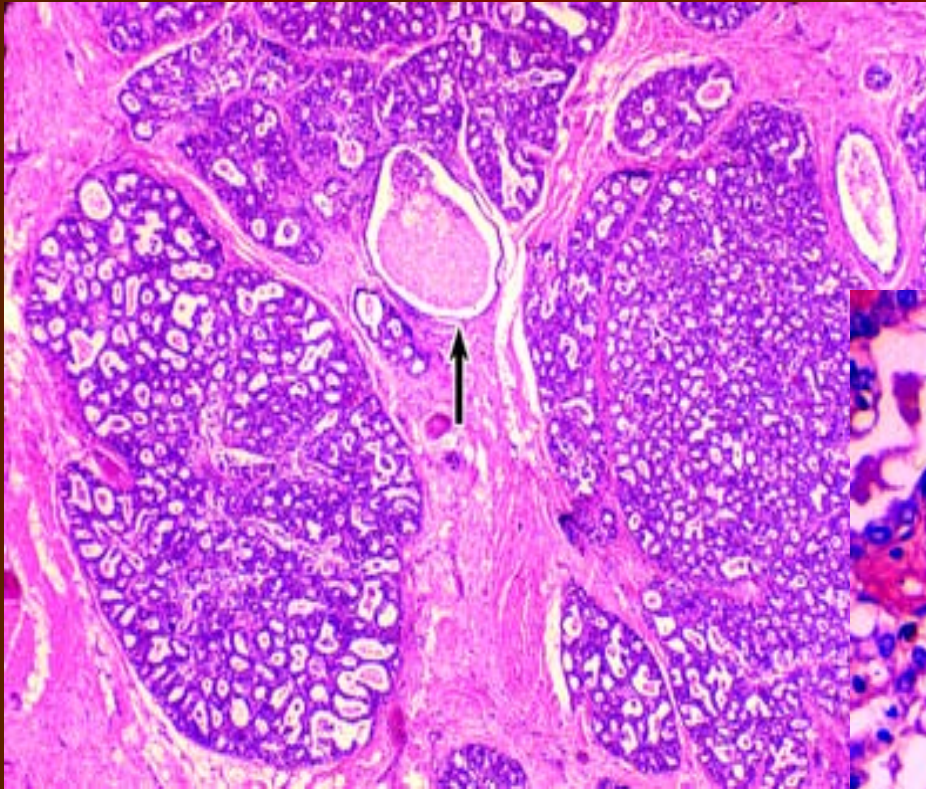
Secreting Cells from the Mammary Gland



Human Breast - inactive



Human Breast - active



Summary IV

- **The vagina**

- A fibromuscular tube that joins internal reproductive organs to the external environment
- Lining a stratified, squamous nonkeratinized epithelium
- Lacking glands

- **Mammary glands**

- Are modified apocrine sweat glands that develop under the influence of sex hormones
- The morphology of the secretory portion varies with the menstrual cycle
- Undergoing dramatic proliferation and development during pregnancy

Summary

- **Ovary**
 - **Follicle development and maturation for oogenesis** (secondary oocyte arrested in the MII before ovulation)
 - **Secrete E and P** by “two cells” theory in follicle or corpus luteum
- **Uterine tube function as fertilization location**
 - If fertilized, mature ovum formed and second polar body eluted
- **Changes of endometrium during different stages of menstrual cycle**
- **Structure of mammary gland**

Thank You All!