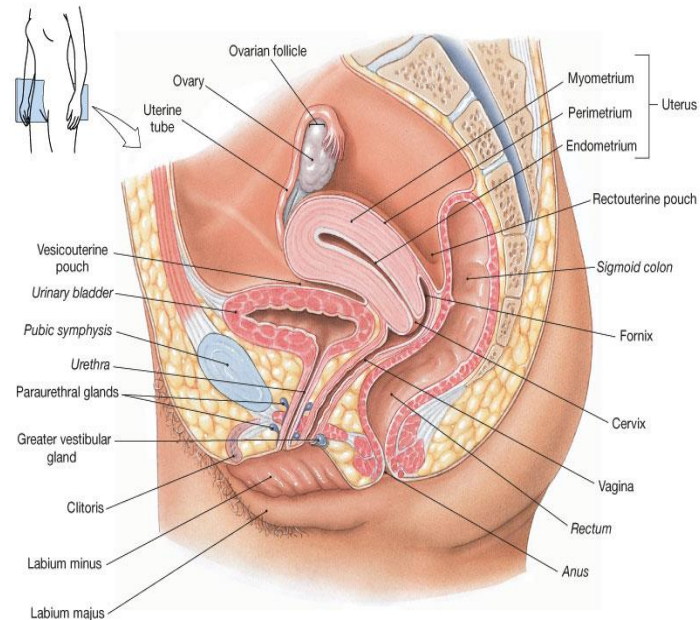


Female reproductive system I

- **Oogenesis**
- **Microscopic structure**
 - Ovarium (ovary)
 - Tuba uterina (oviduct)
 - Uterus
 - Vagina
 - Placenta and umbilical cord
- **Ovarian and menstrual cycle**



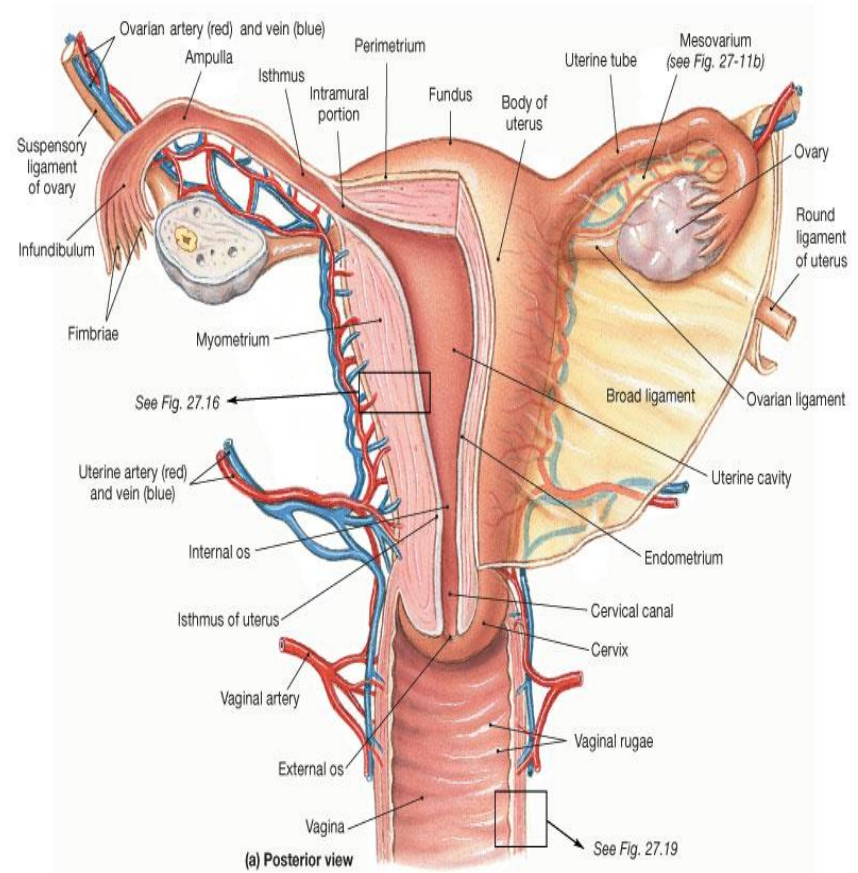
1) Sex gland (gonad): ovarium

2) Excretory ducts:

- oviduct
- uterus
- vagina

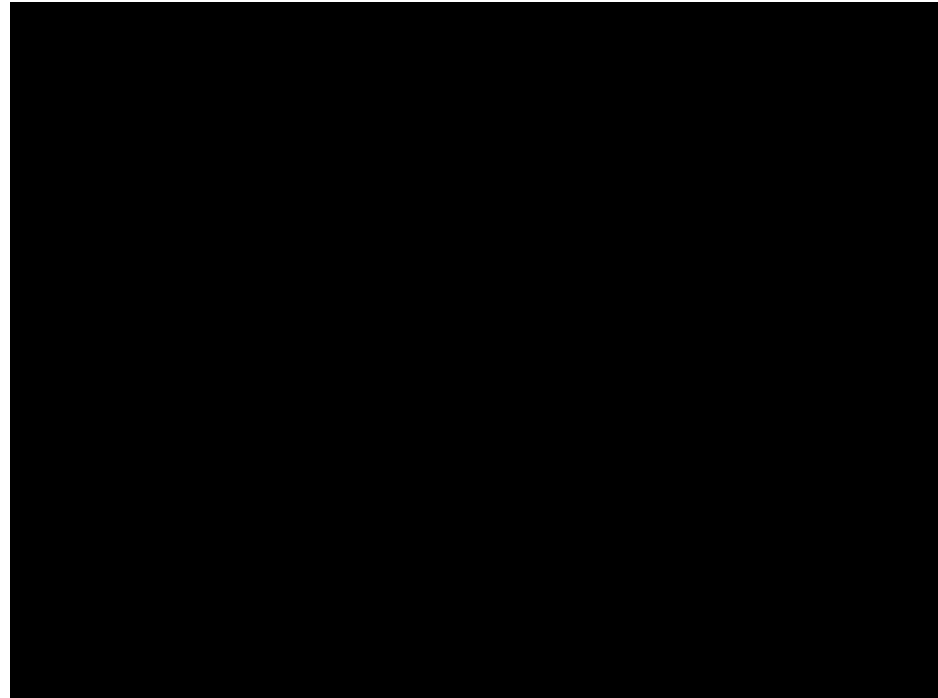
3) External genitalia:

- clitoris
- labia majoris et minoris

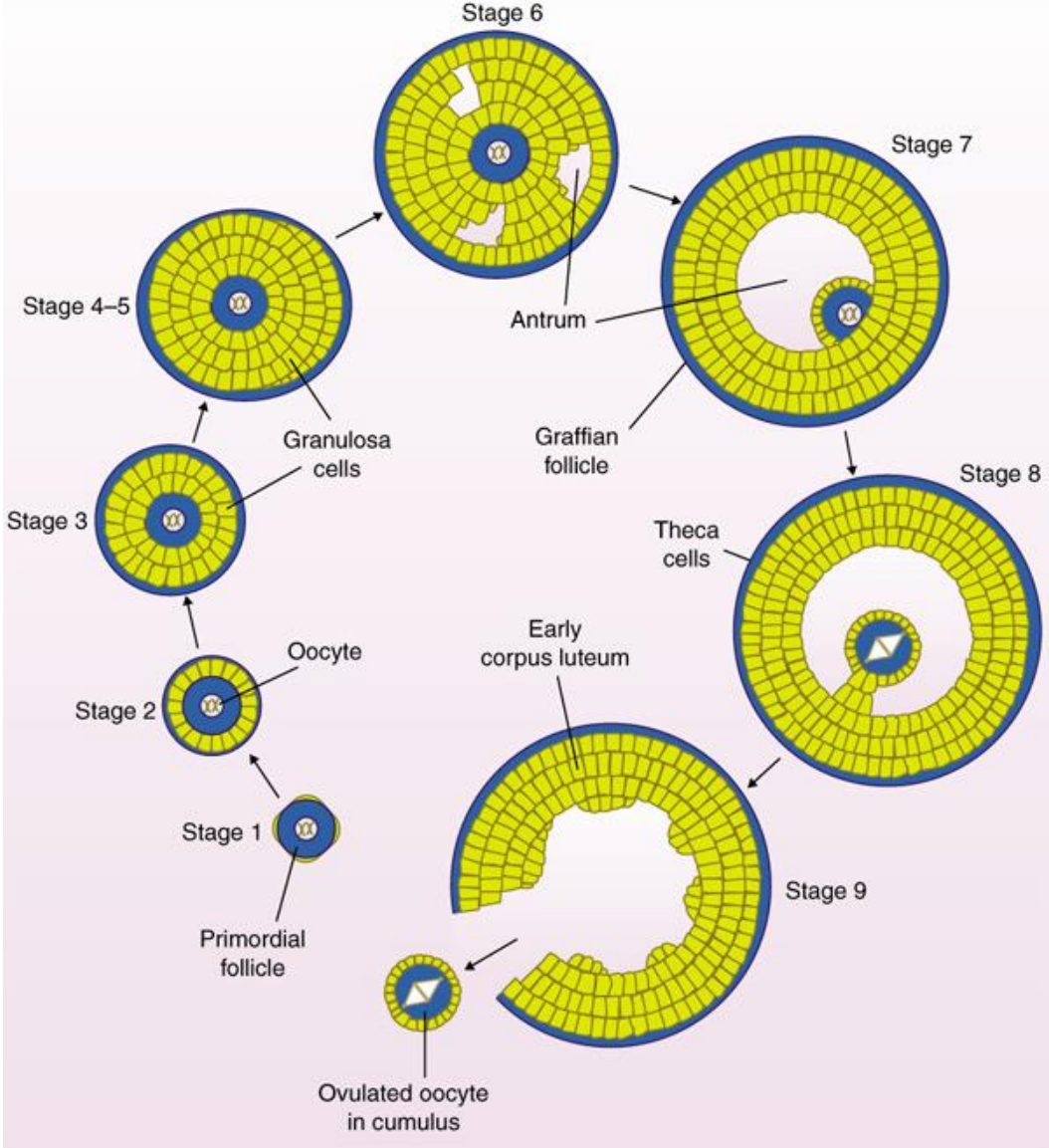


Oogenesis

- Process of formation of the **oocyte**, the female gamete, **in ovaries**
- Protective structure necessary for proper oocyte nutrition, maturation and ovulation = **follicle**
- **Ovarian cycle** is governed by hormones secreted by **hypothalamus-adenohypophysis** and **follicular cells** and is linked to menstrual cycle



Follicular development – ovarian cycle



Oocyte development

Oogonia mitotically divide



1/3 of oogonia enters meiosis I



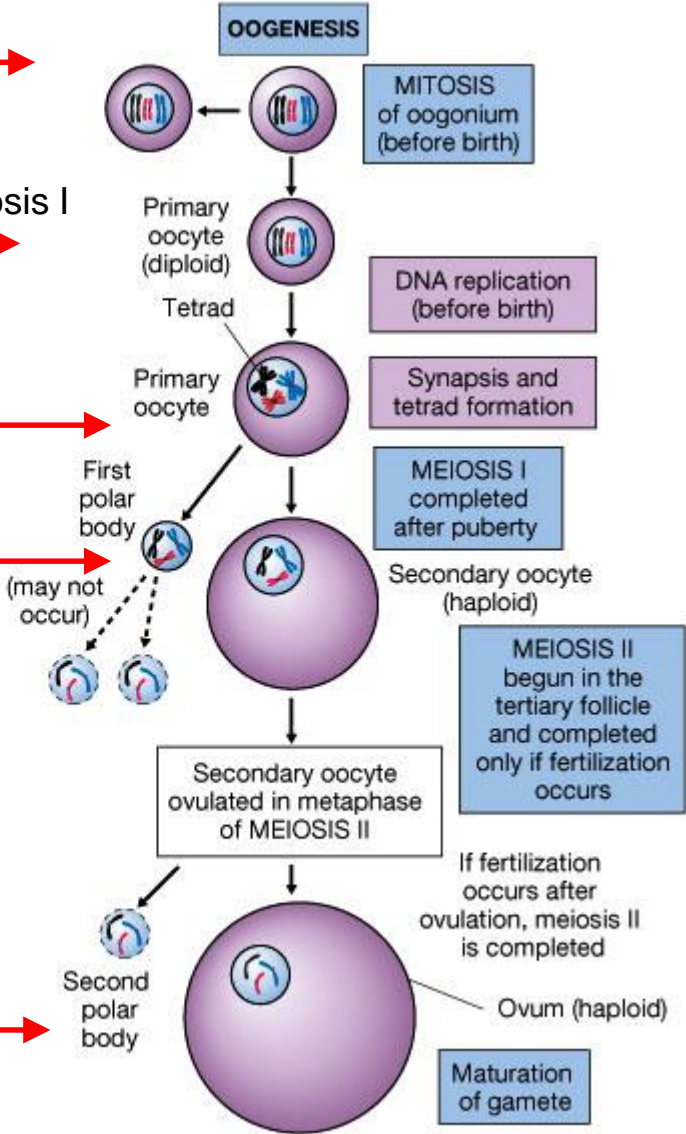
Meiosis I stopped at late prophase - dictyotene



Meiosis I completed 48-36 hrs before ovulation



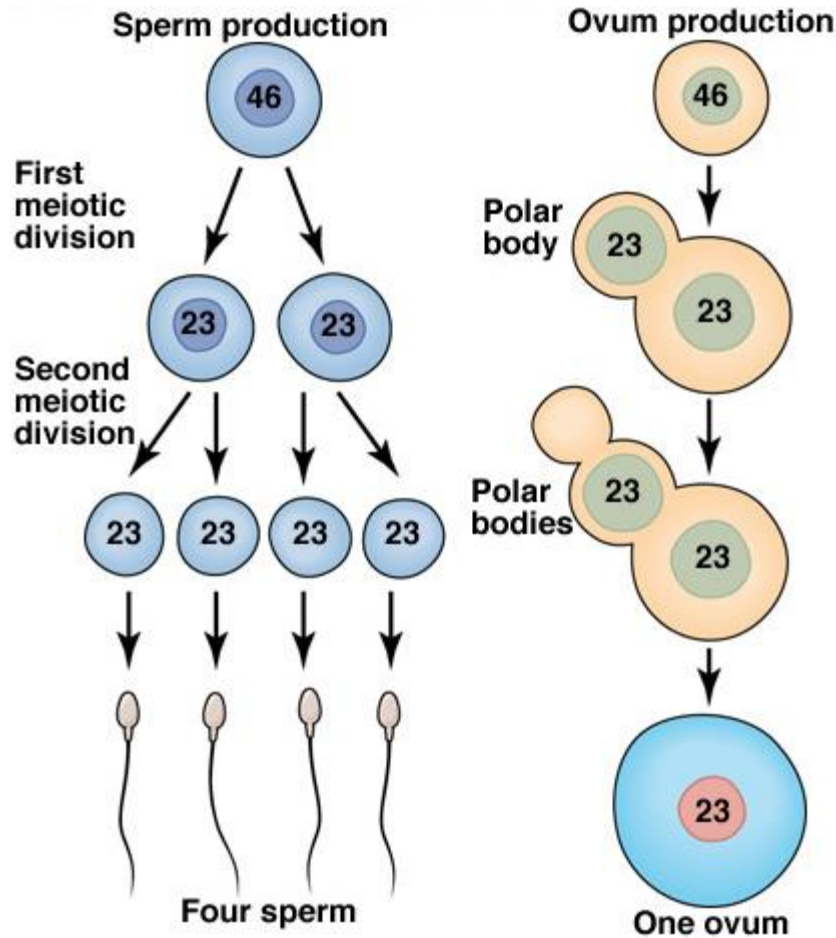
Meiosis II completed after fertilization



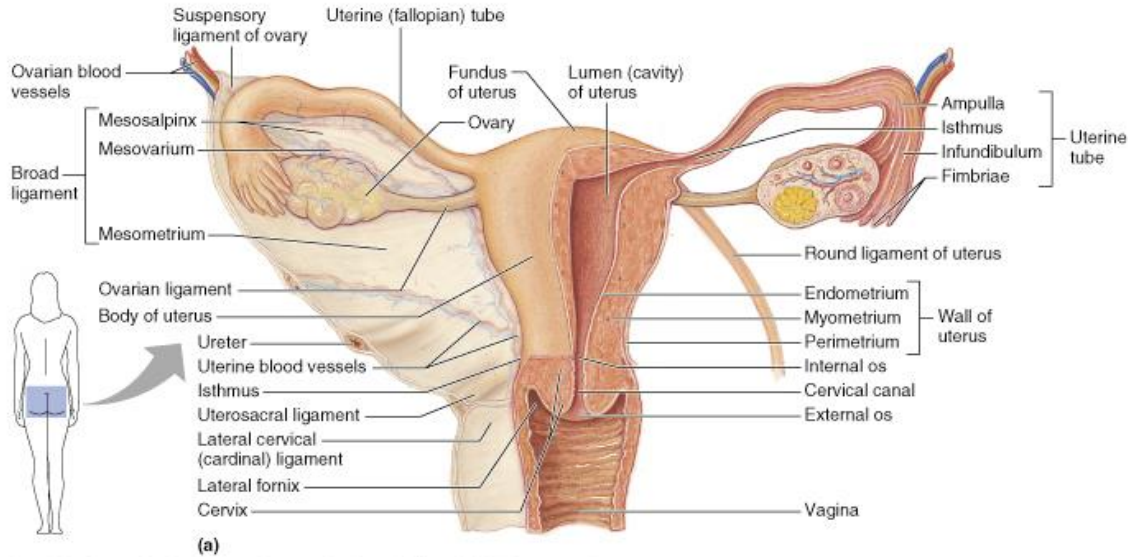
Important terms

- **Oogonia** (6×10^6 at the end of 5th month i.u.)
- **Primary oocyte** (2×10^6 at the end of 7th month i.u.)
- **Secondary oocyte** immediately enters meiosis II, stop in metaphase and **ovulate**
- Oocyte is fertilized by a sperm - meiosis II is completed, **ovum** forms
- **Zygote** is formed and immediately starts to divide

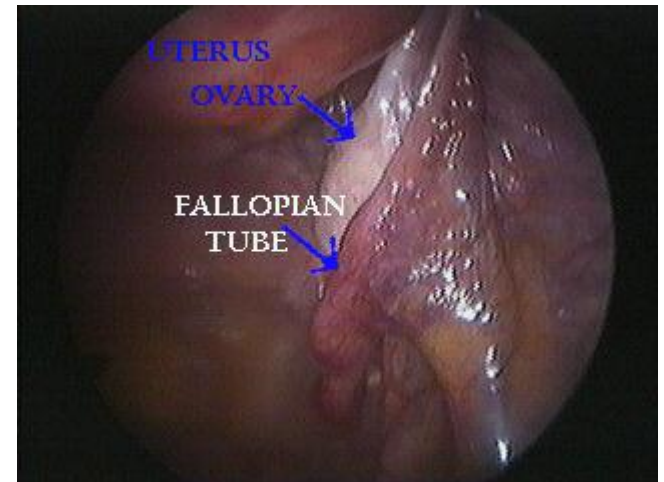
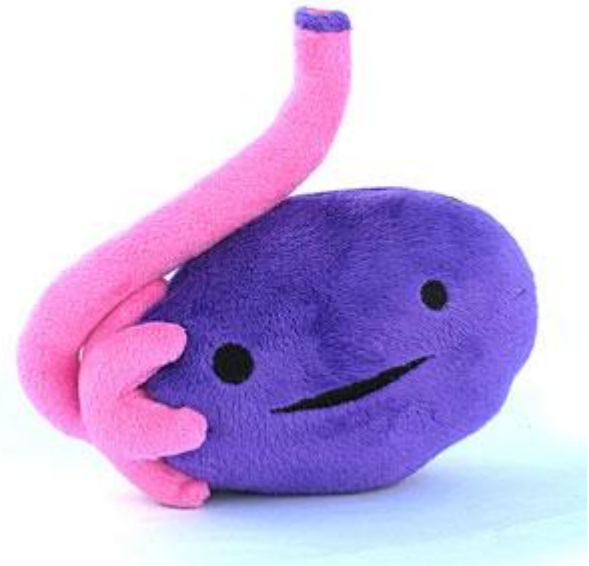
Spermatogenesis vs. oogenesis



Ovary - anatomy

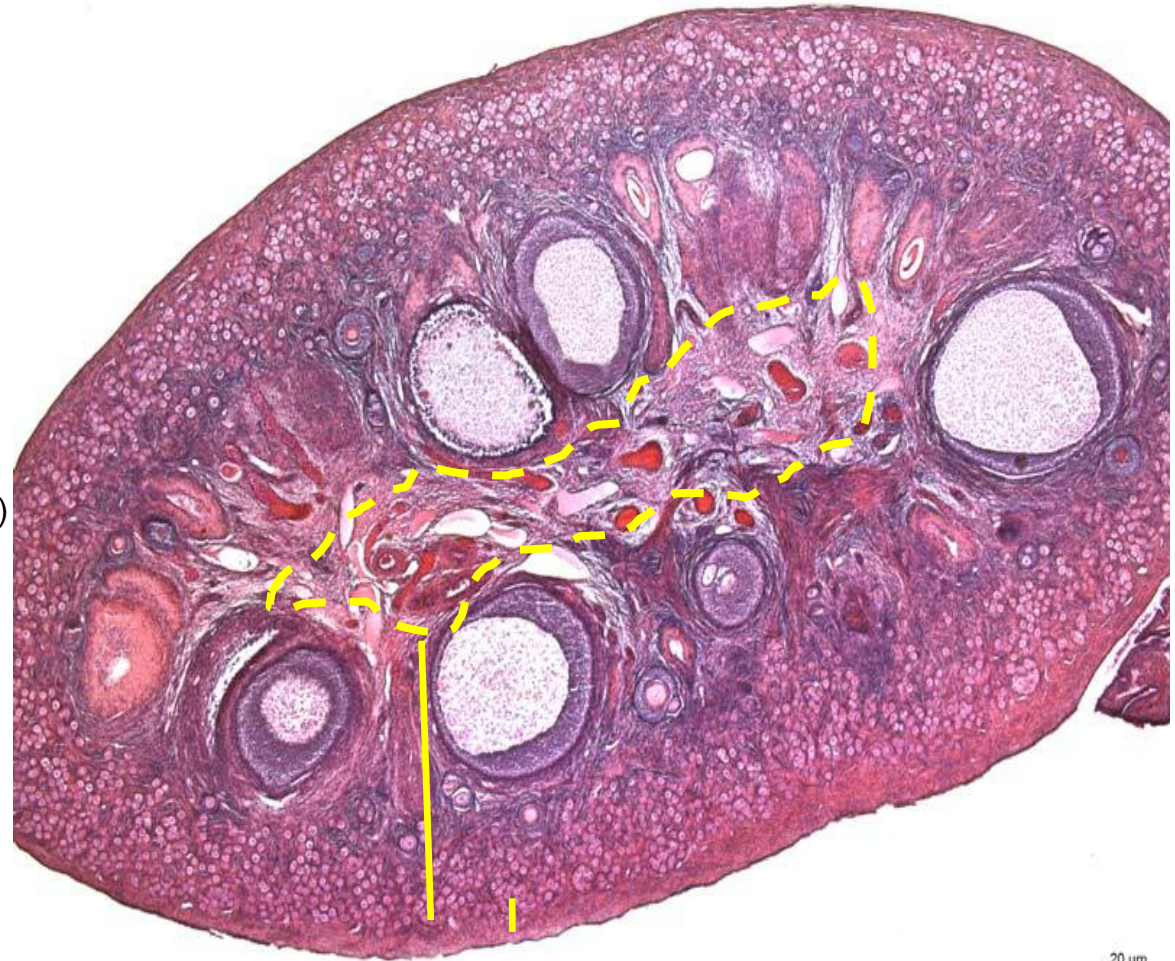


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Ovarium (3 x 1,5 x 1 cm)

- **germinative epithelium**
 - source of follicular cells
- **tunica albuginea ovarii**
(0,05 – 0,08 mm)
- **cortex** (follicles)
- **medulla** (zona vasculosa, vascularisation)



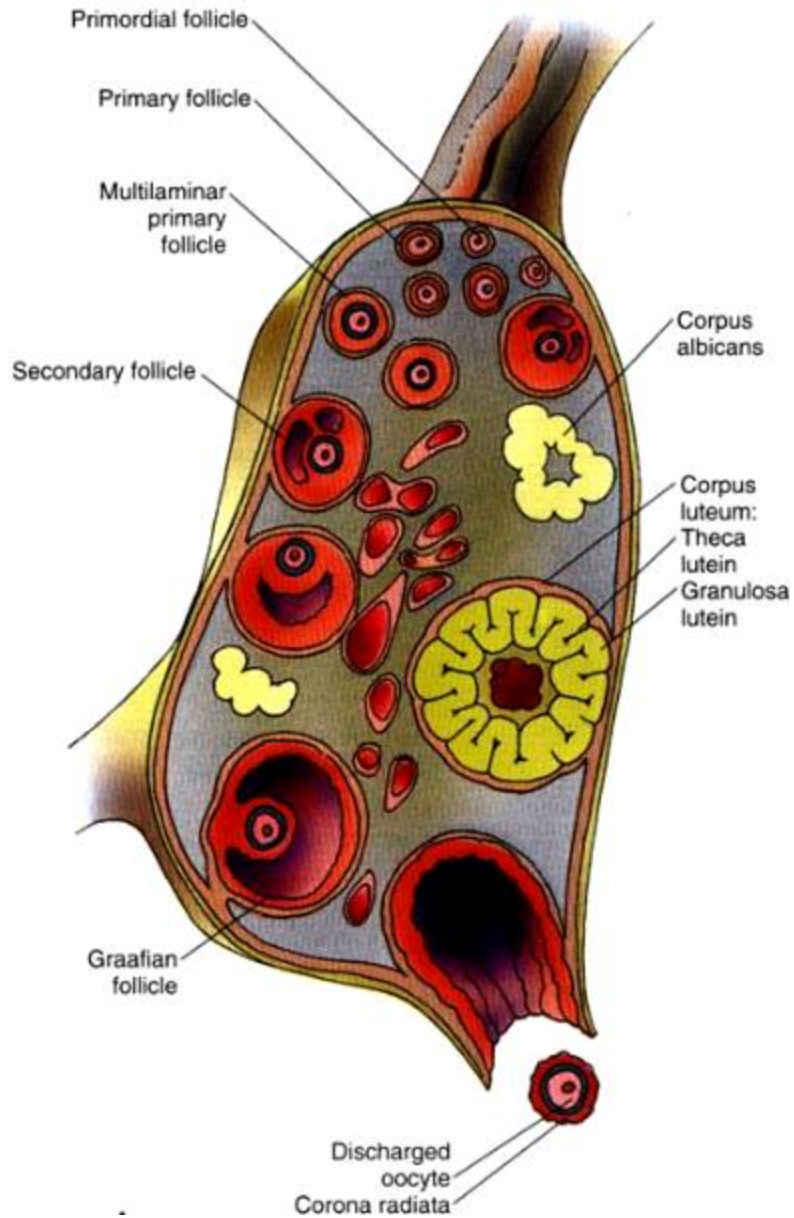
Ovarium – important terms

- **ovarial follicles:**

1. primordial
2. growing: primary unilaminar, primary multilaminar, secondary
3. mature: Graafian follicle
4. atretic (degenerated) follicles

- **corpus luteum**

- **corpus albicans**



Primordial follicle \varnothing 40 – 50 μm

- oocyte \varnothing 25 – 30 μm
- single layer of flat follicular cells

Primary follicle

unilaminar \varnothing 60 – 75 μm

multilaminar \varnothing 200 – 250 μm

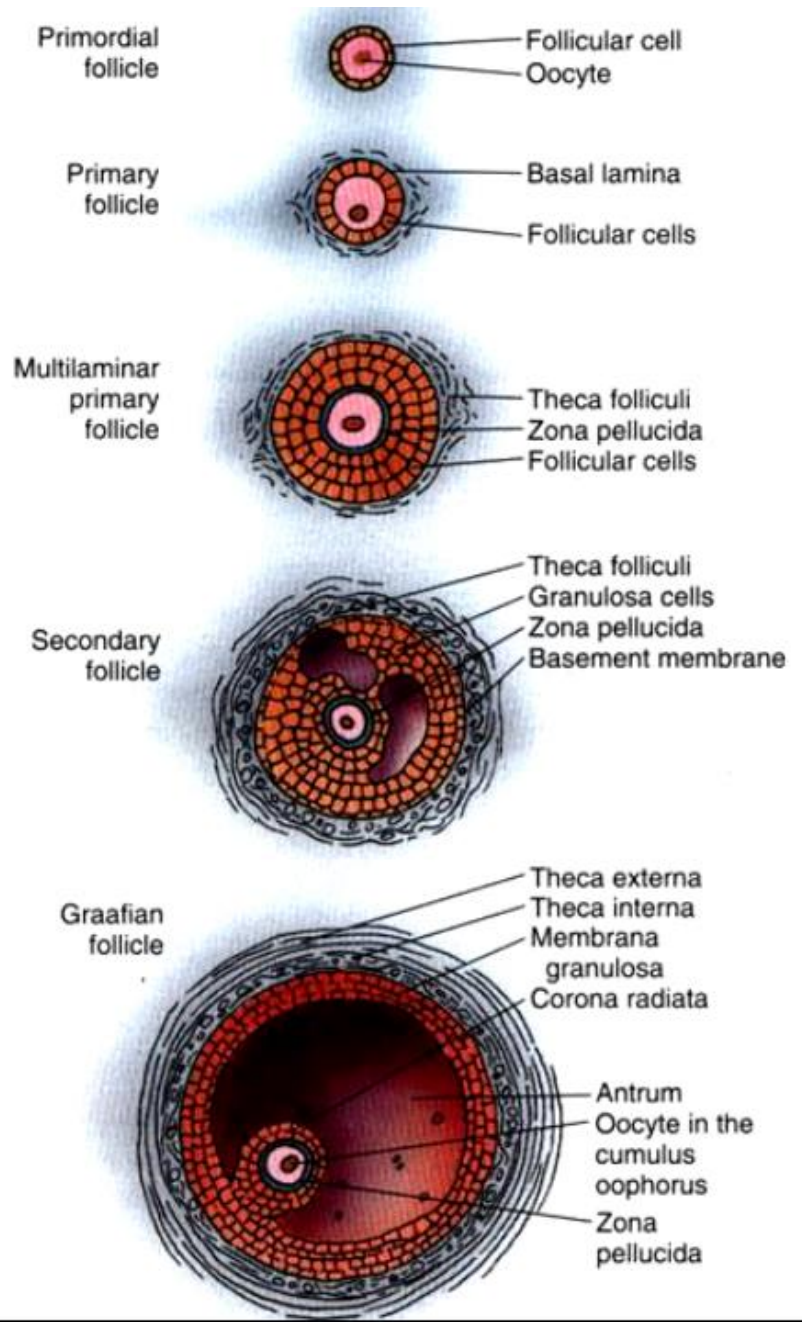
- oocyte \varnothing 50 - 80 μm
- zona pellucida (ZP)
- one or more layers of follicular cells
membrana granulosa (MG)
- corona radiata (CR)
- theca folliculi

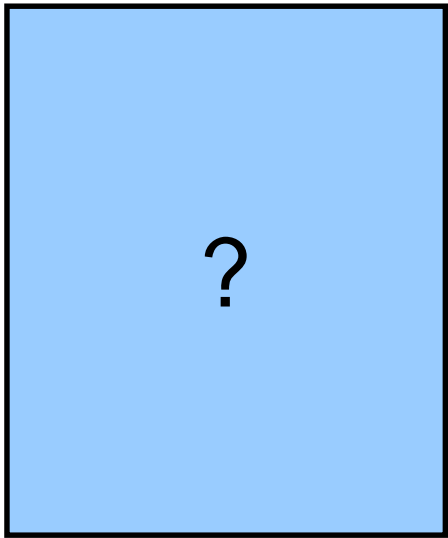
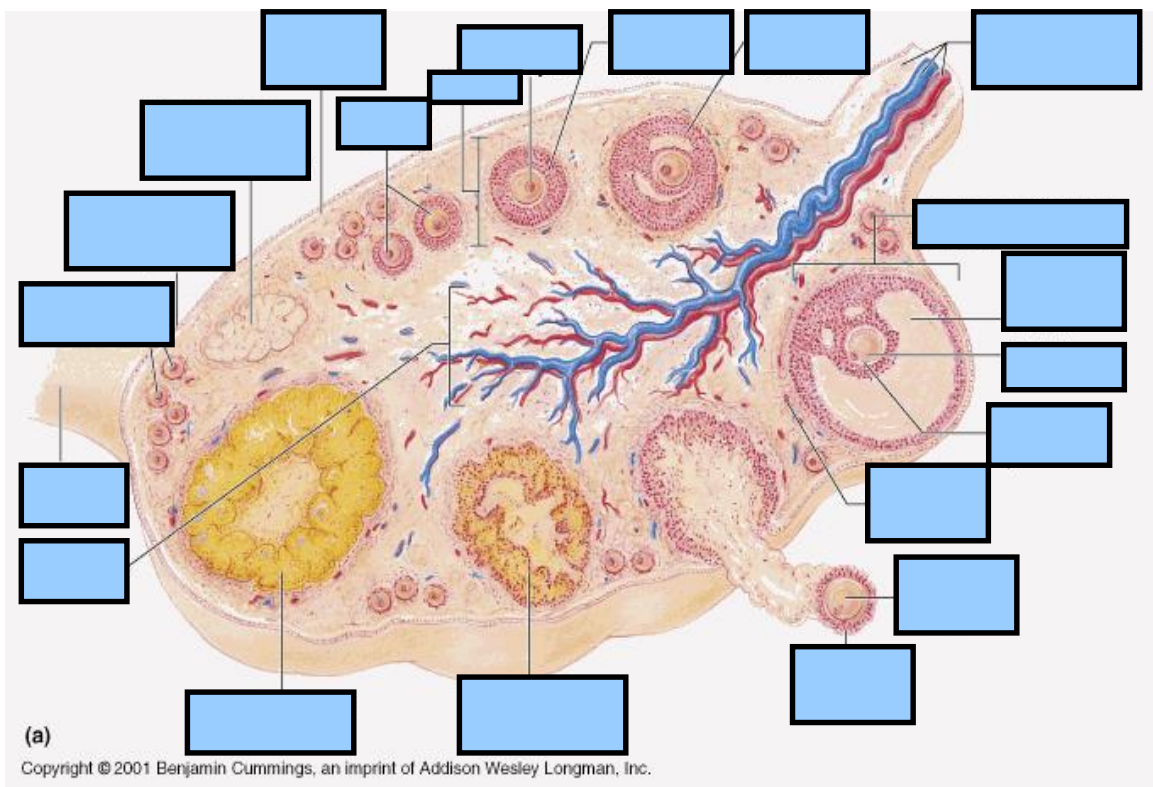
Secondary follicle \varnothing 0,2 – 0,8 mm

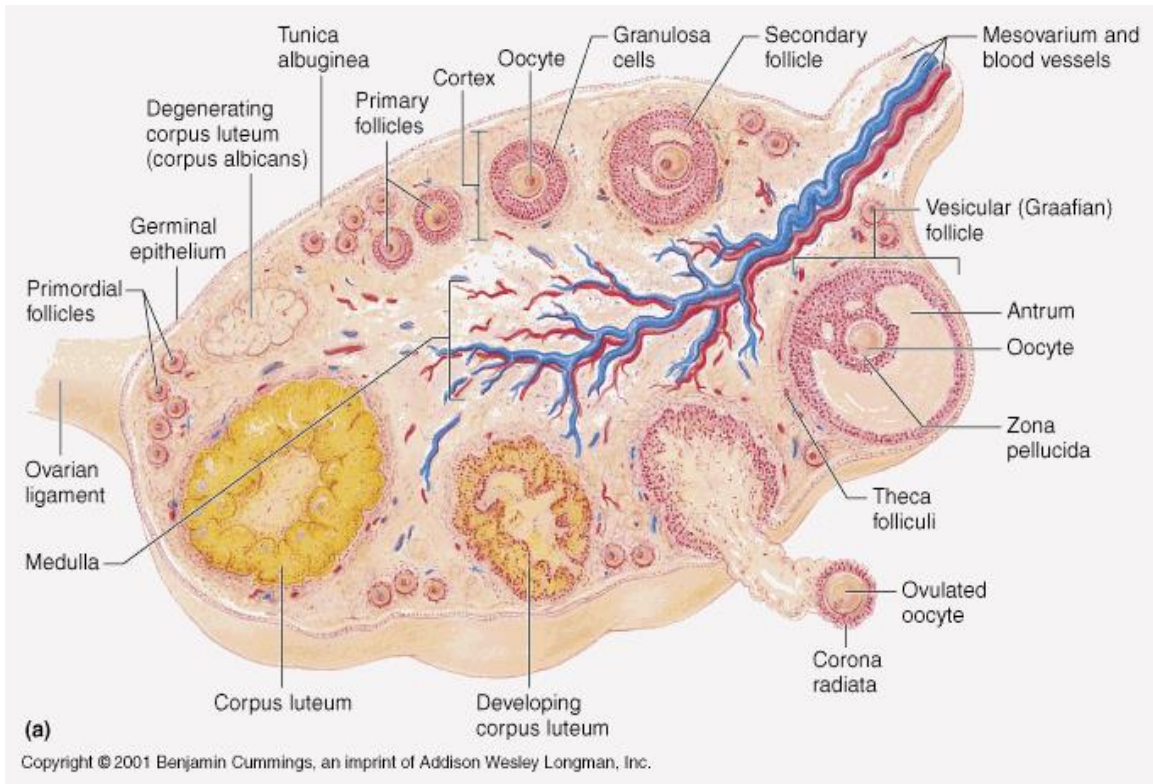
- oocyte \varnothing 100 μm
- ZP, MG, CR – cavities
- theca folliculi interna + externa

Graafian follicle \varnothing 1,5 – 2,0 cm

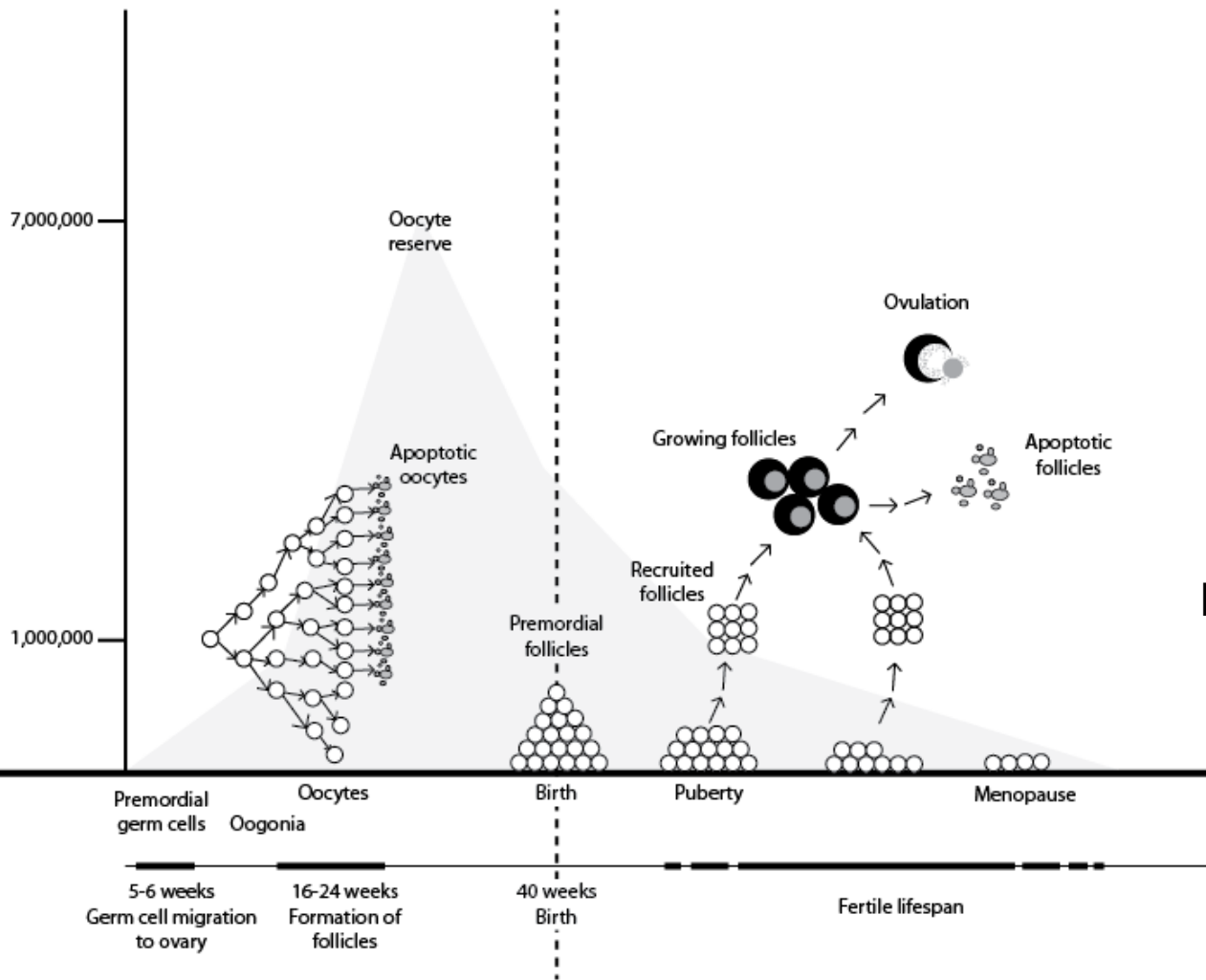
- oocyte \varnothing 100 - 150 μm
- ZP, MG, CR – cumulus oophorus,
- antrum folliculi
- theca folliculi interna + externa



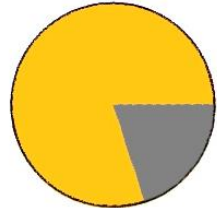




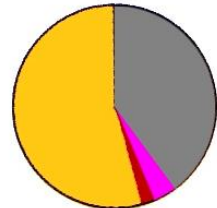
Age-related changes in follicular development



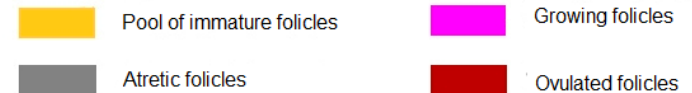
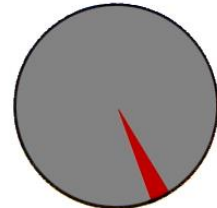
Pre-puberty



Fertility

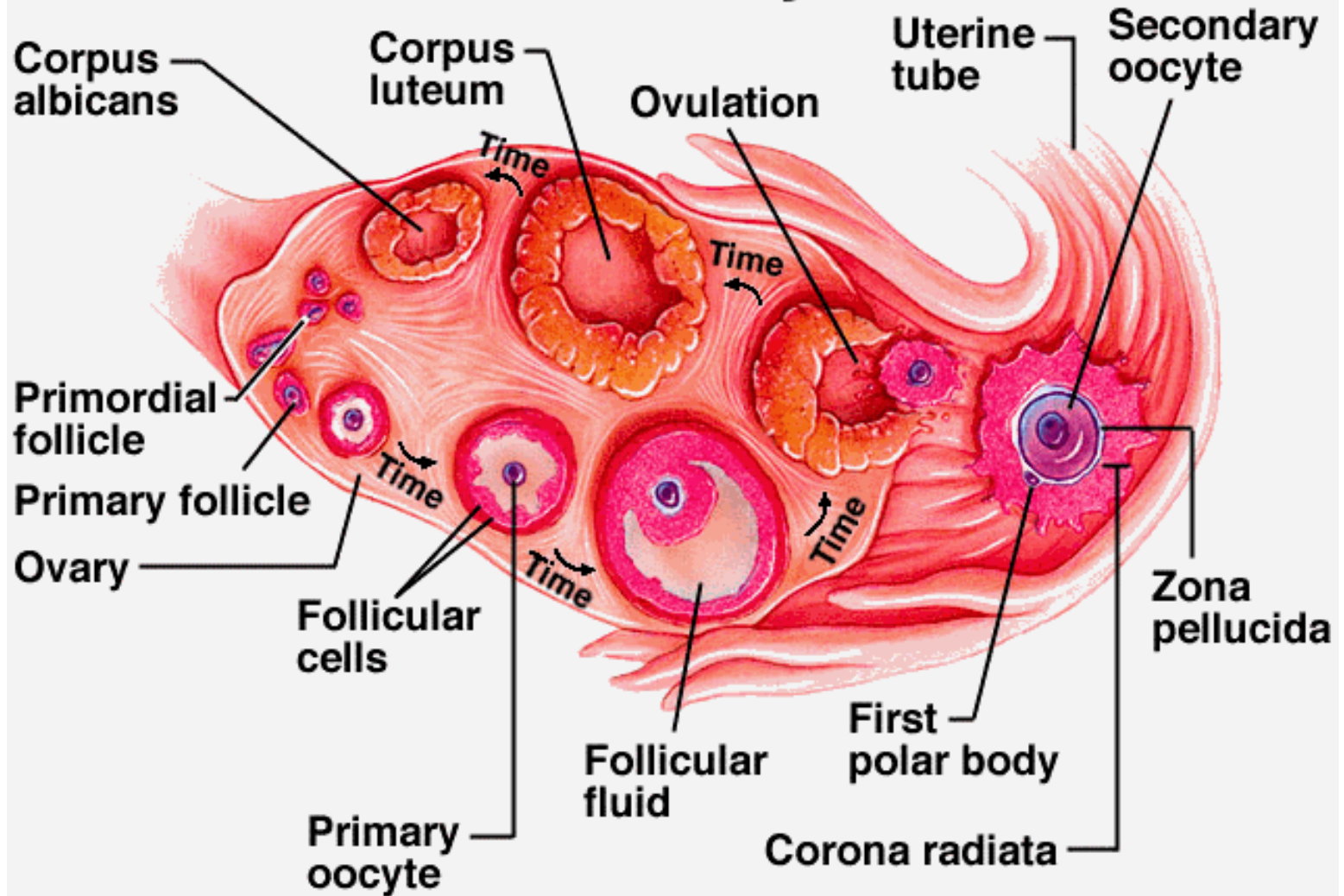


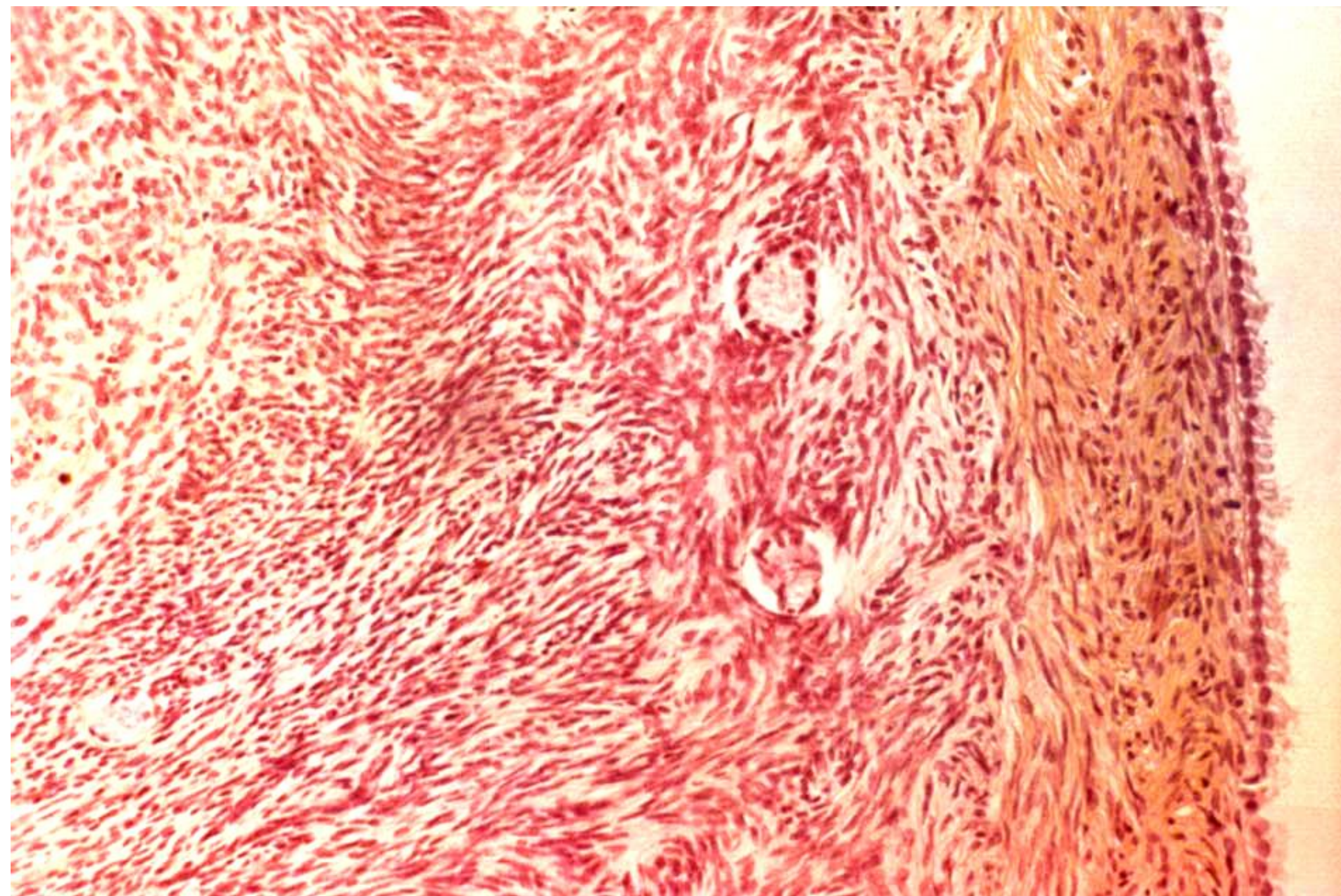
Post-menopause

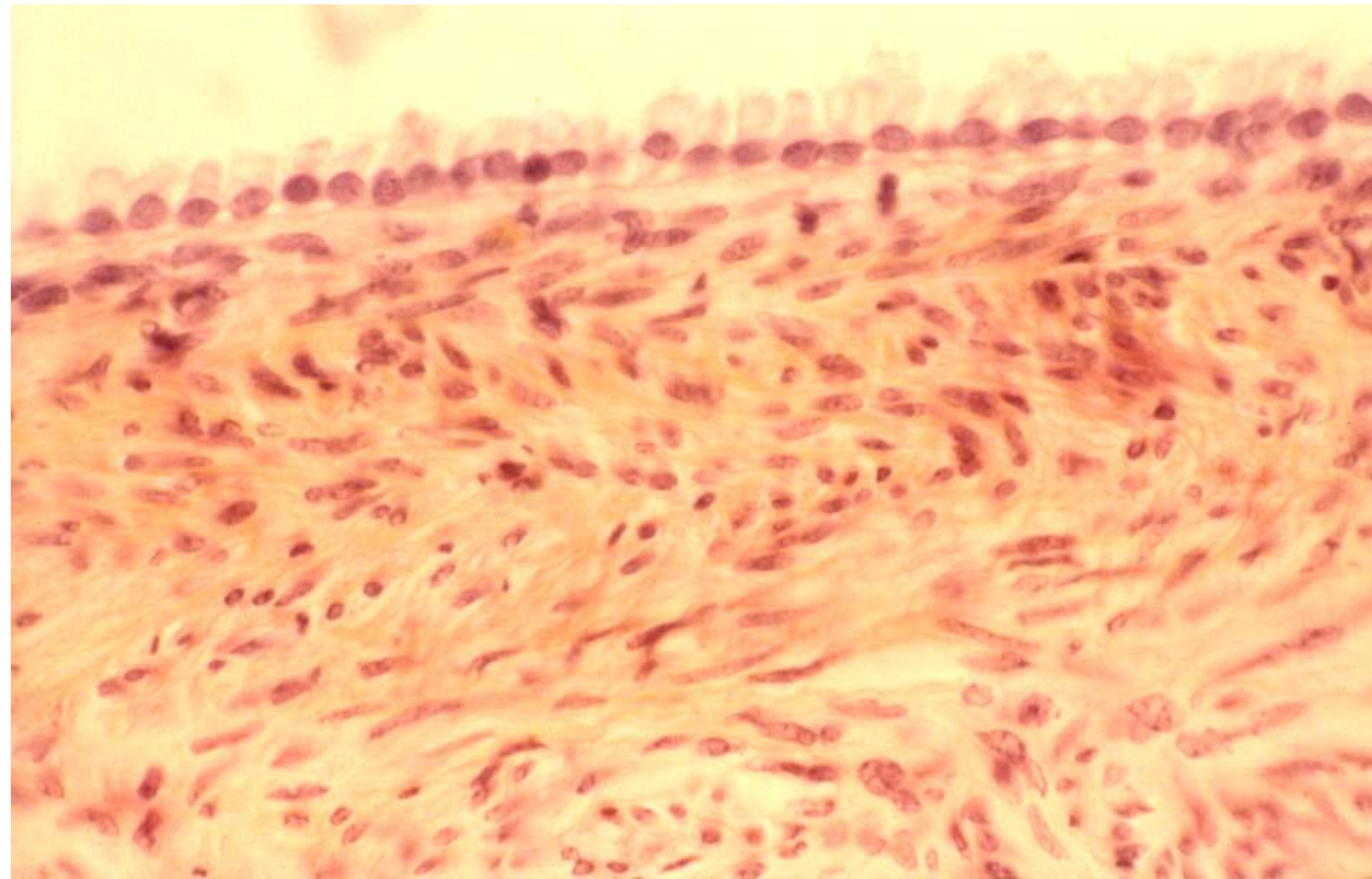


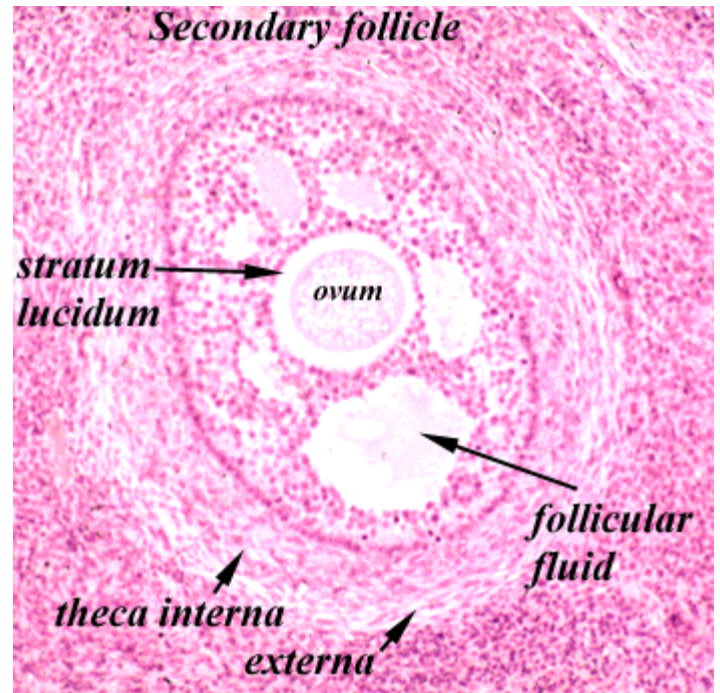
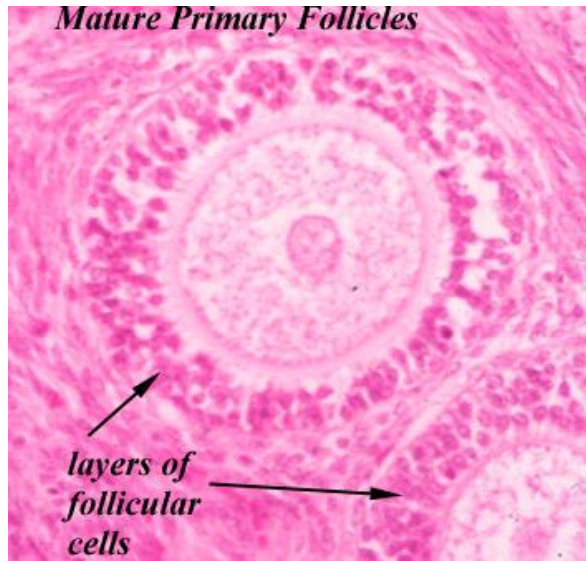
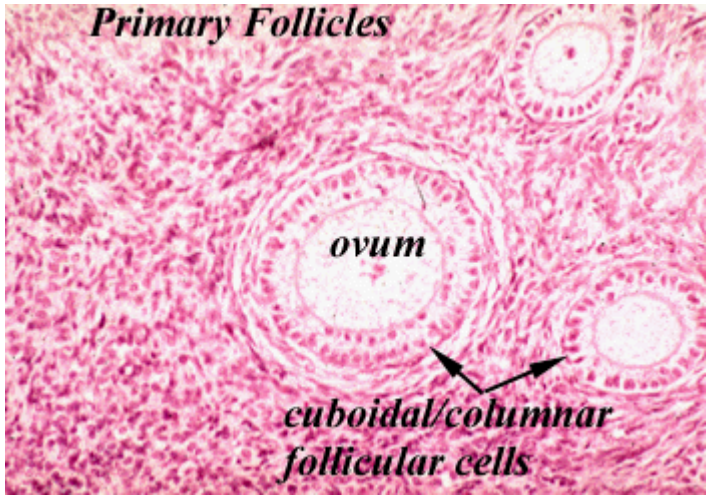
Follicular degeneration – atresia

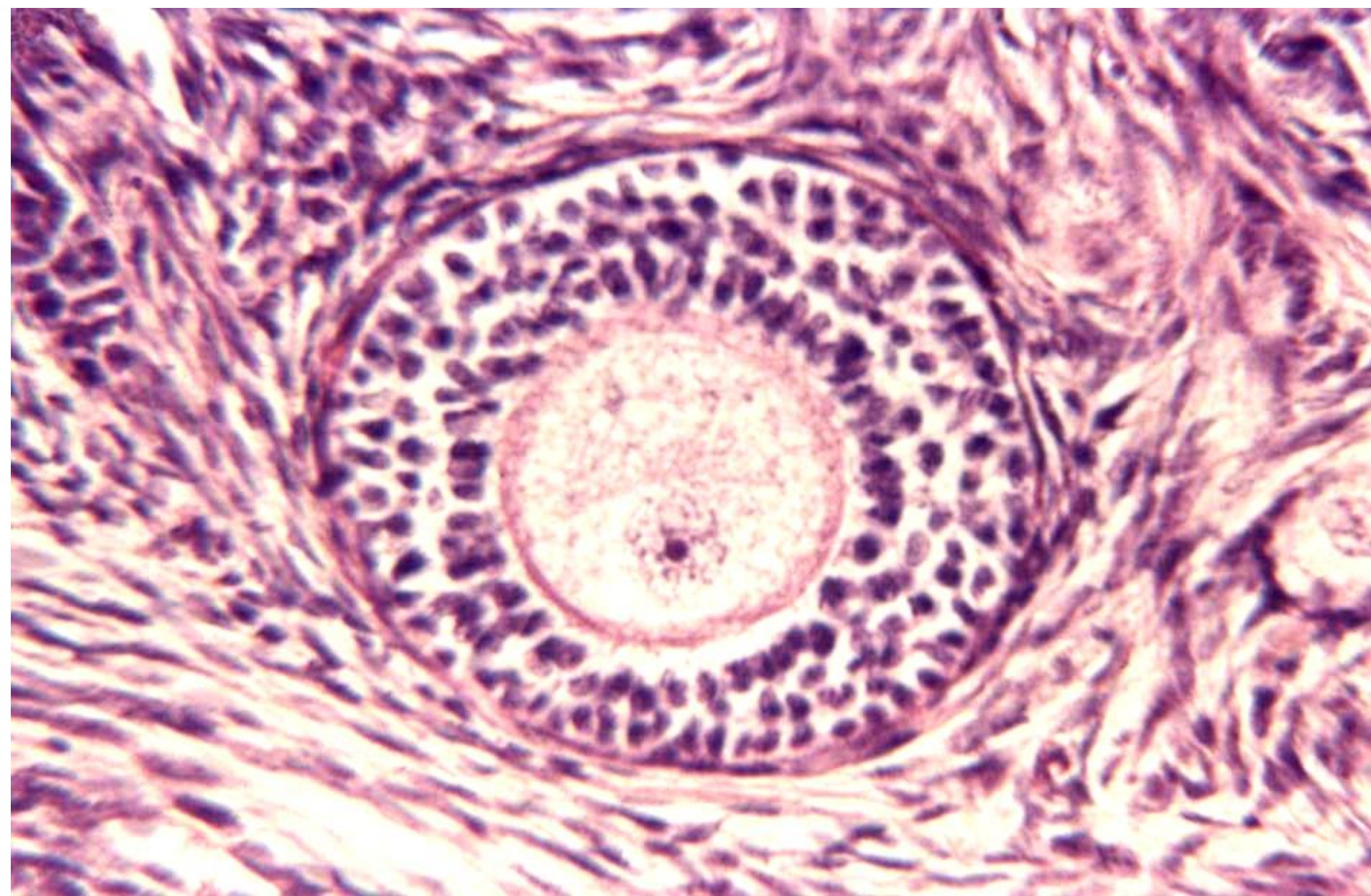
Ovarian Cycle

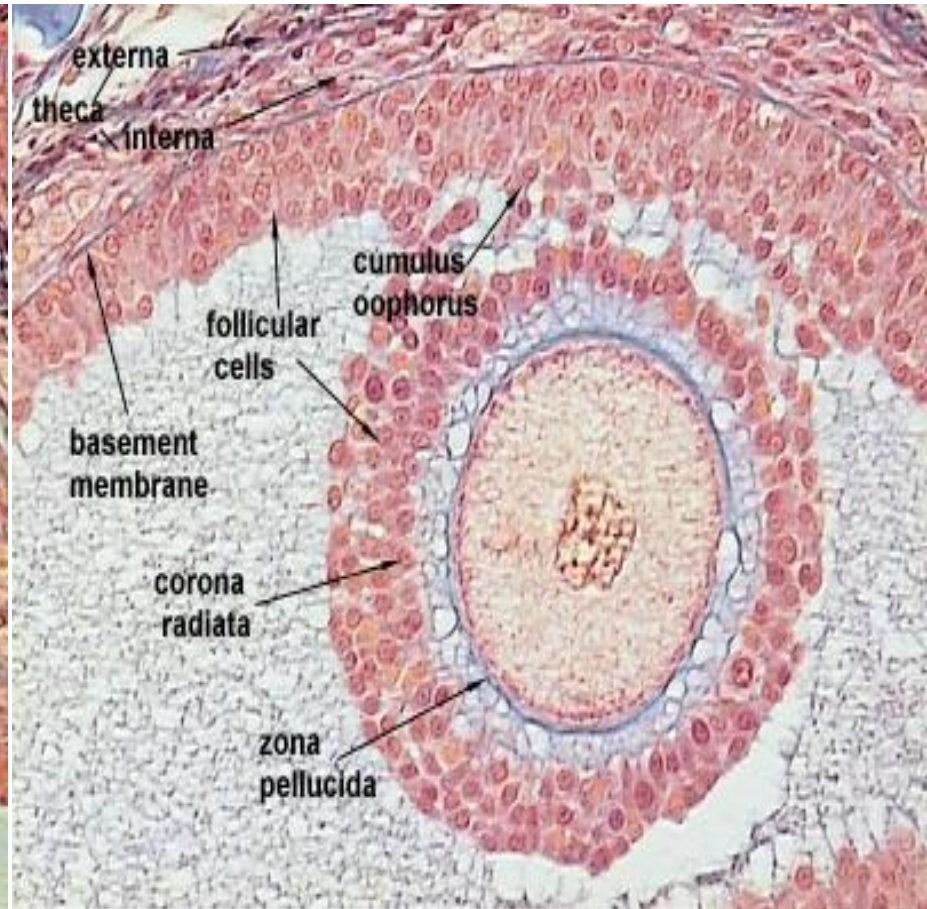
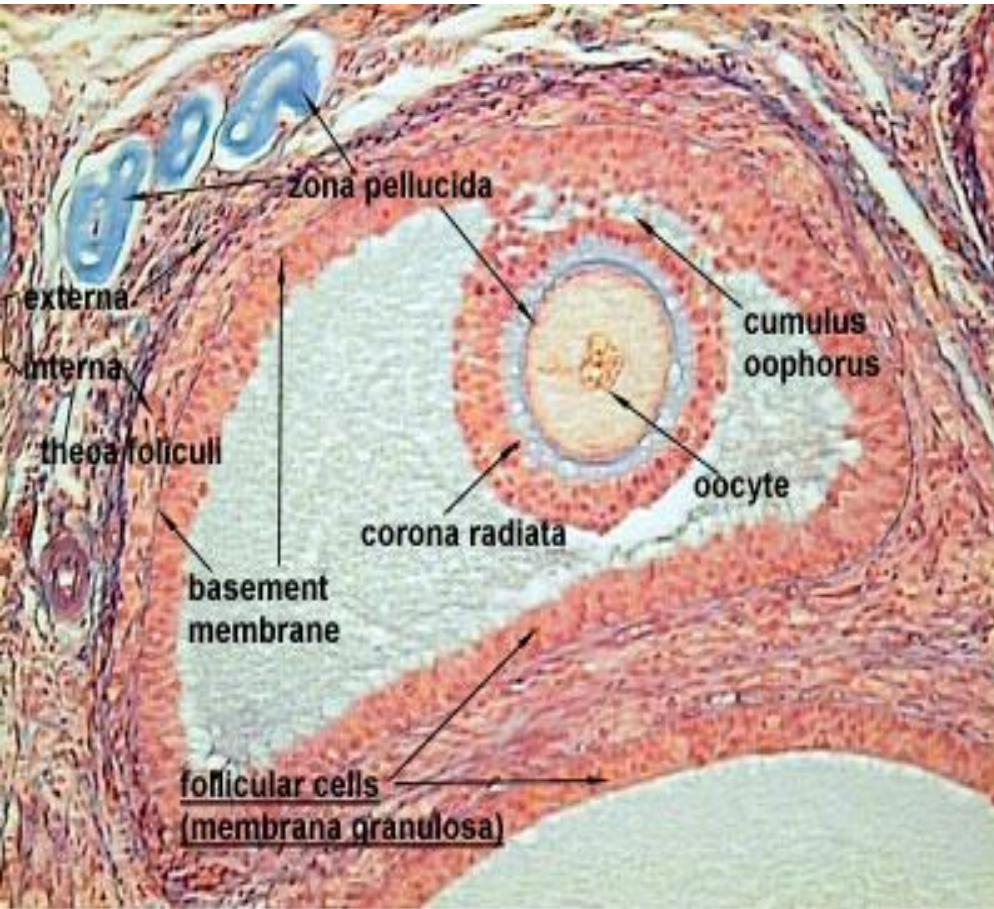


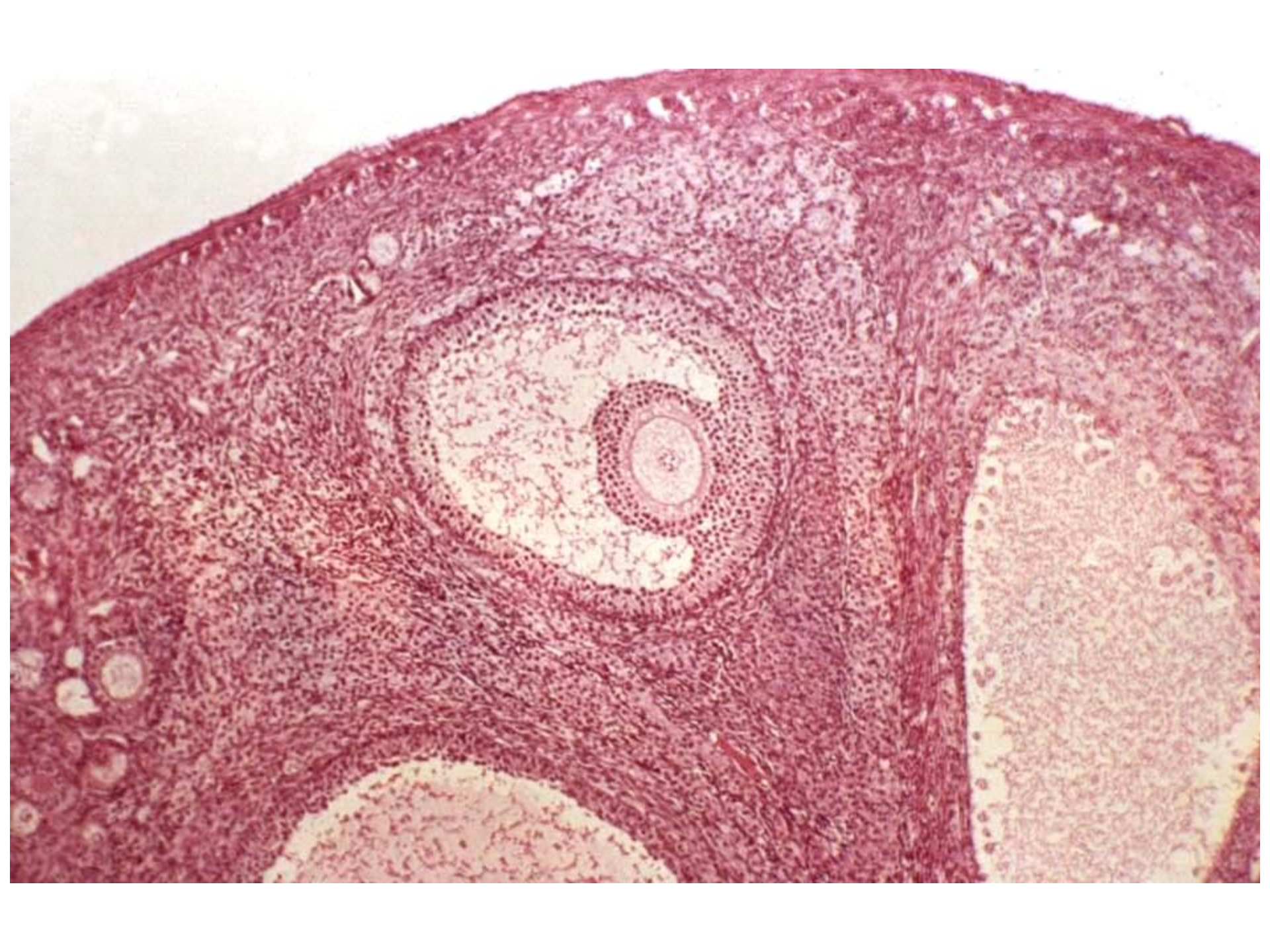


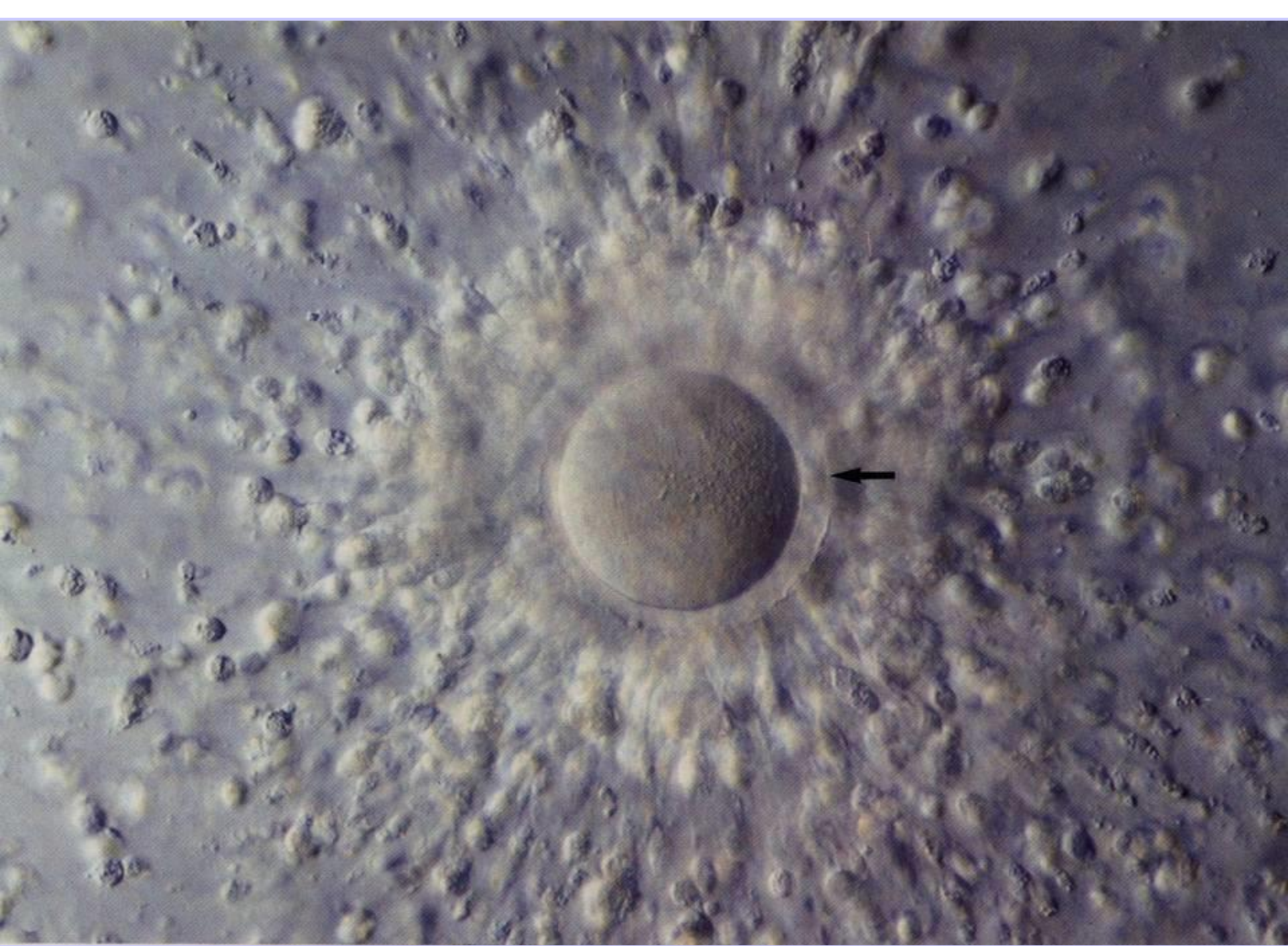




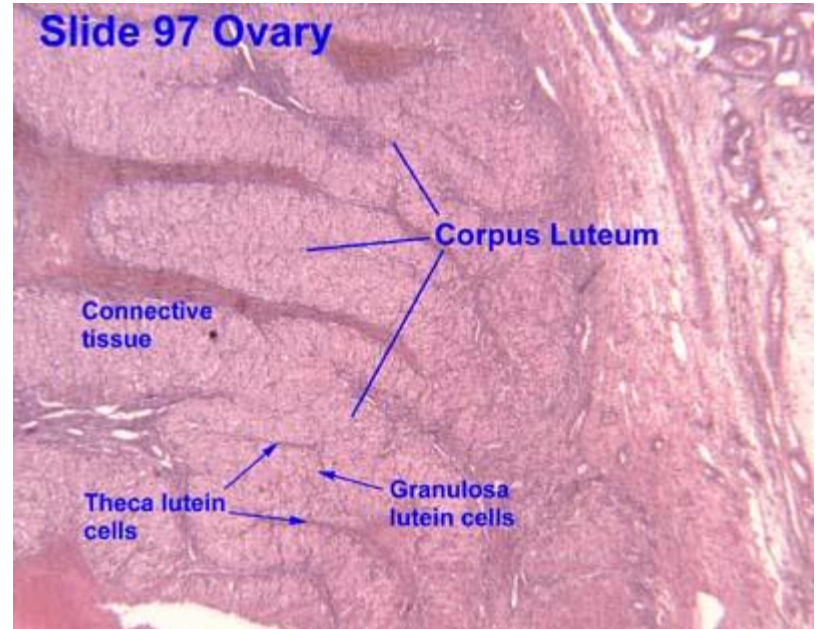




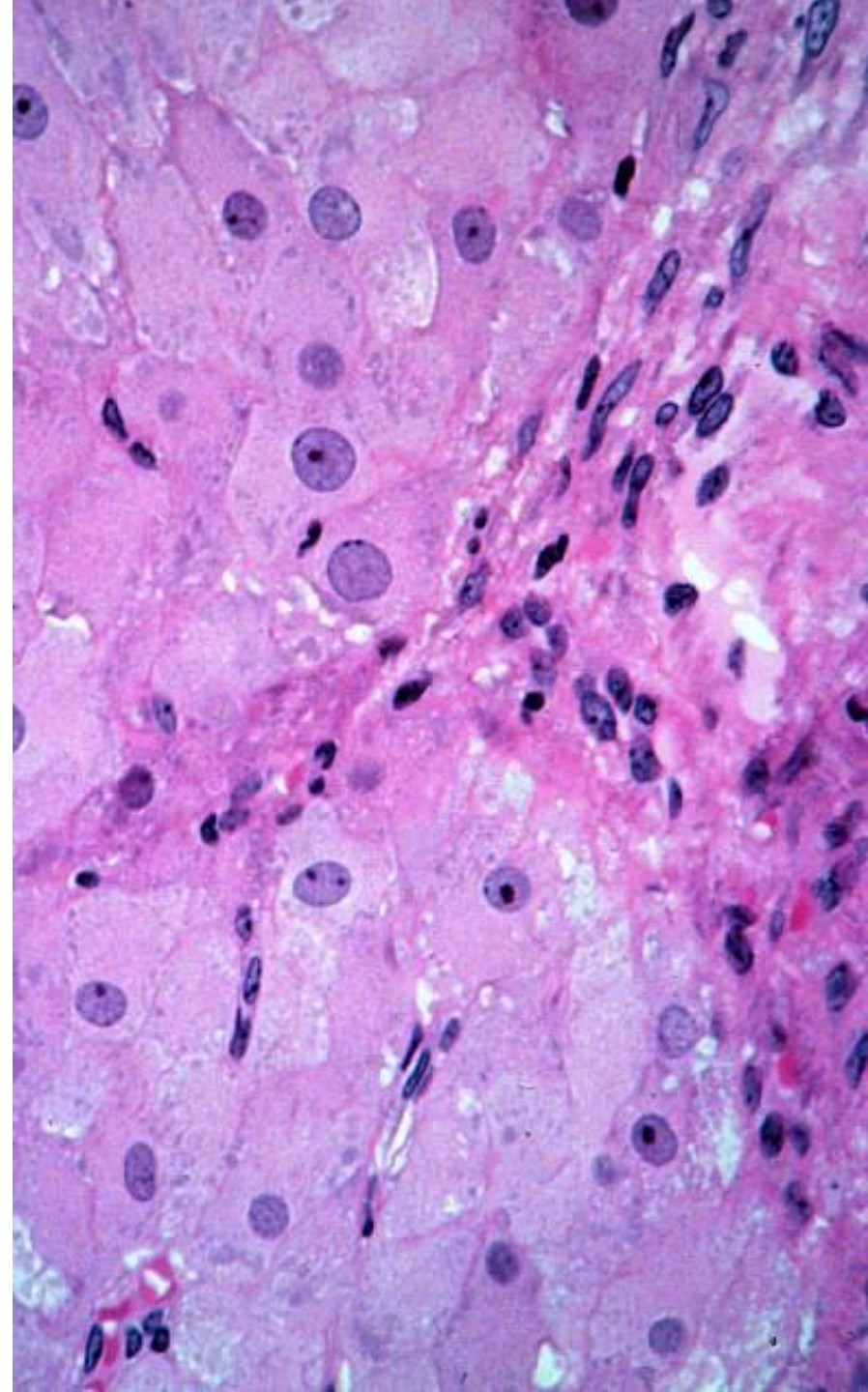




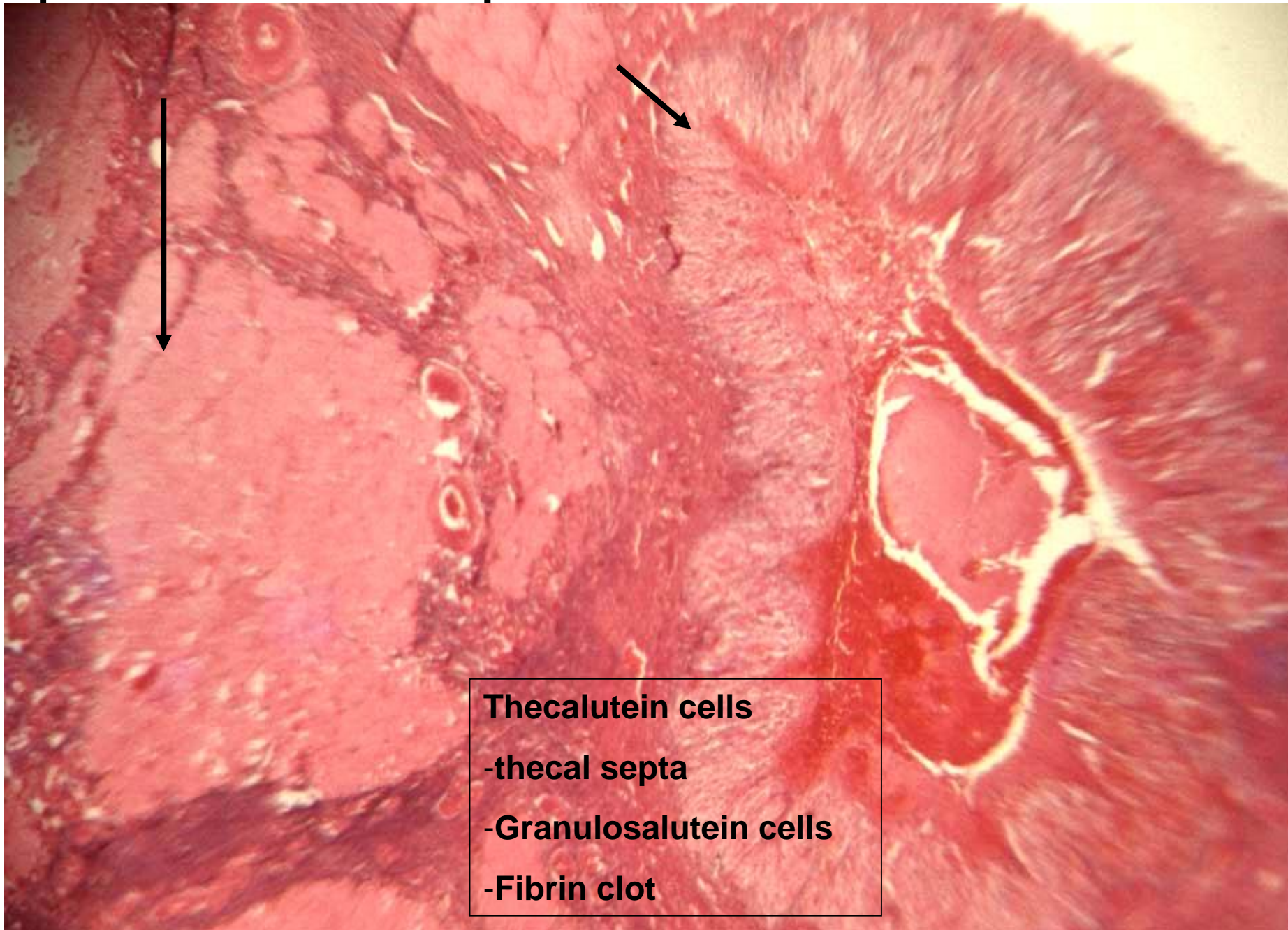
Corpus luteum



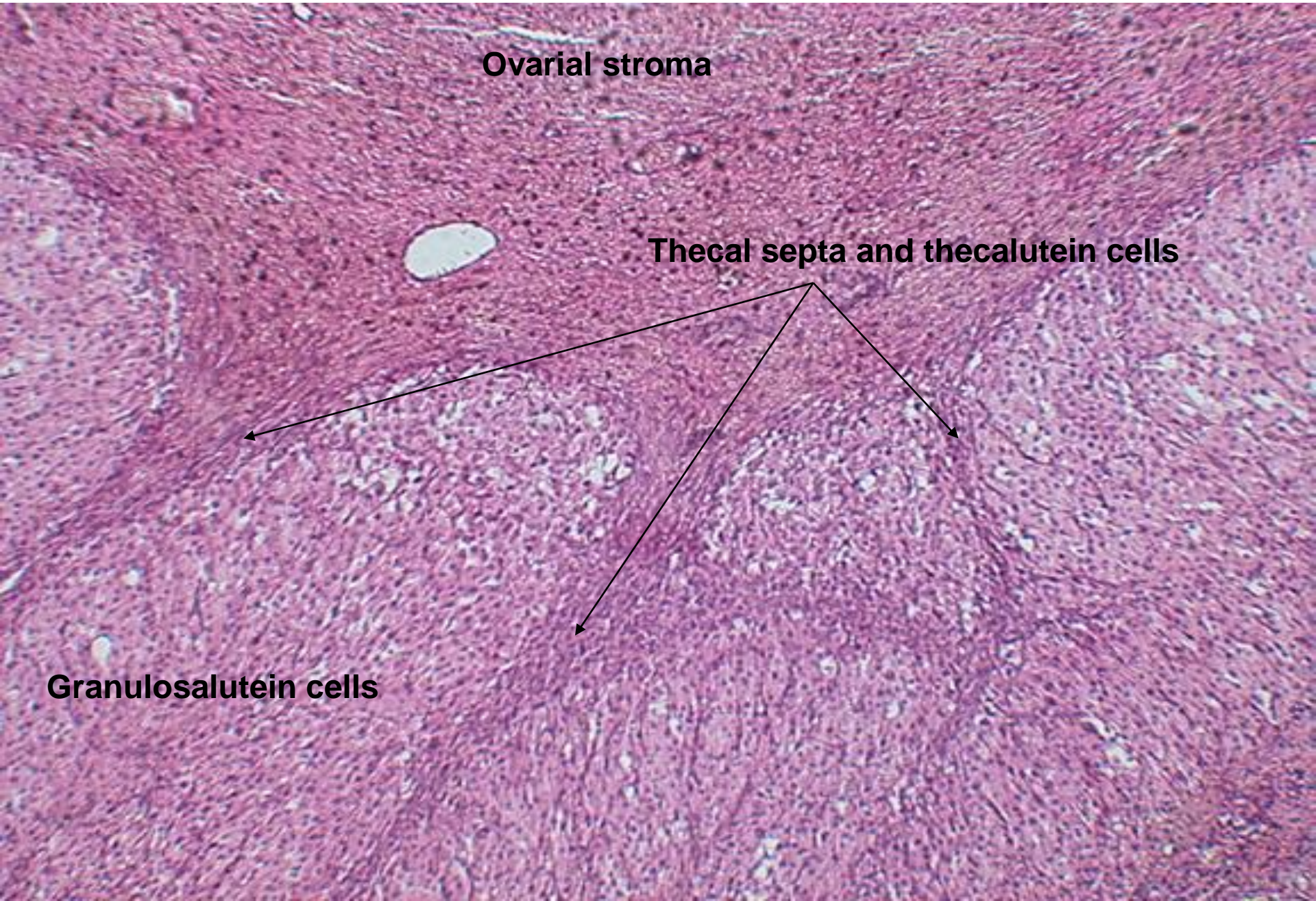
Corpus luteum



Corpus albicans and corpus luteum

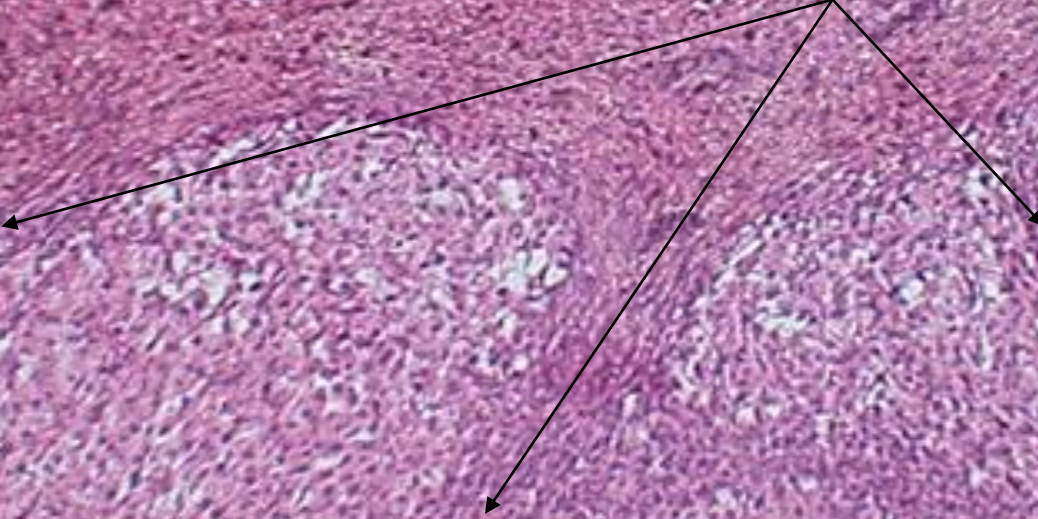


Corpus luteum



Ovarial stroma

Thecal septa and thecalutein cells



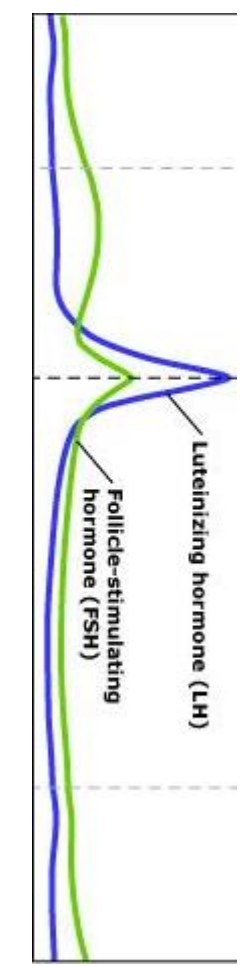
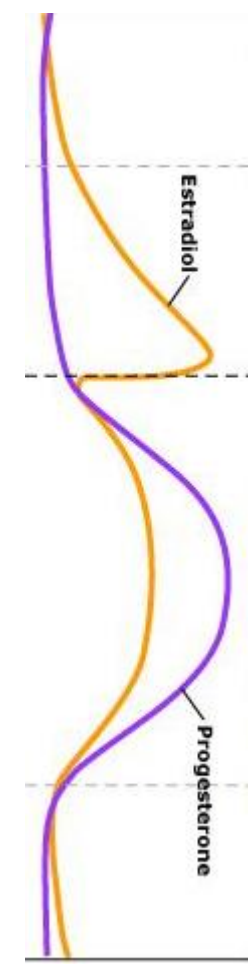
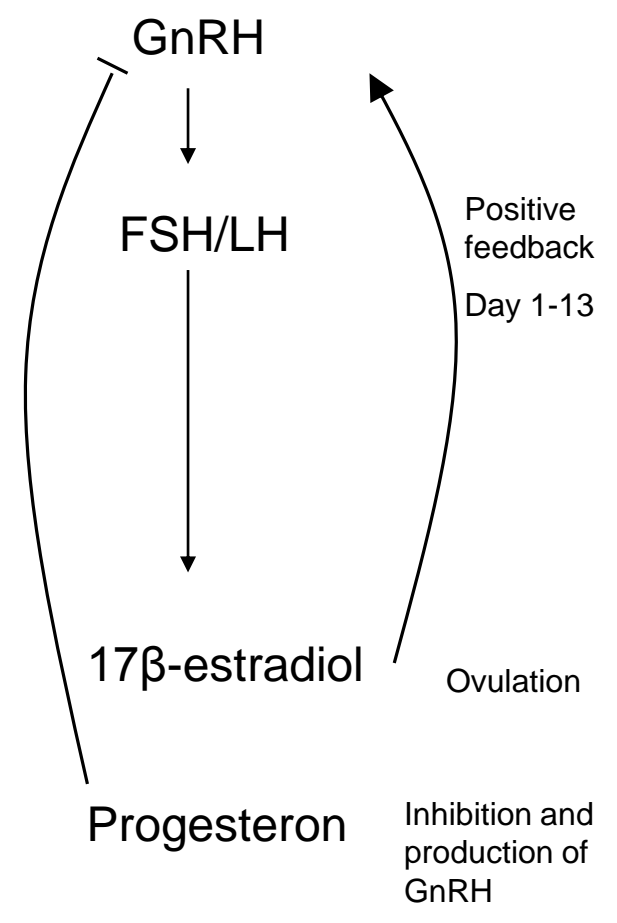
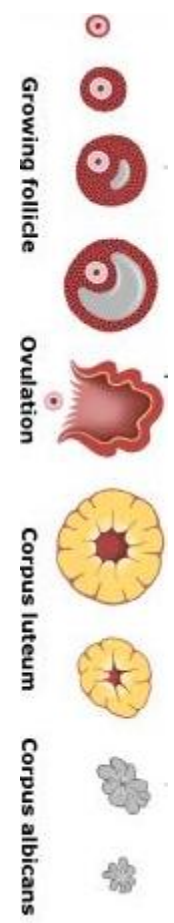
Granulosalutein cells

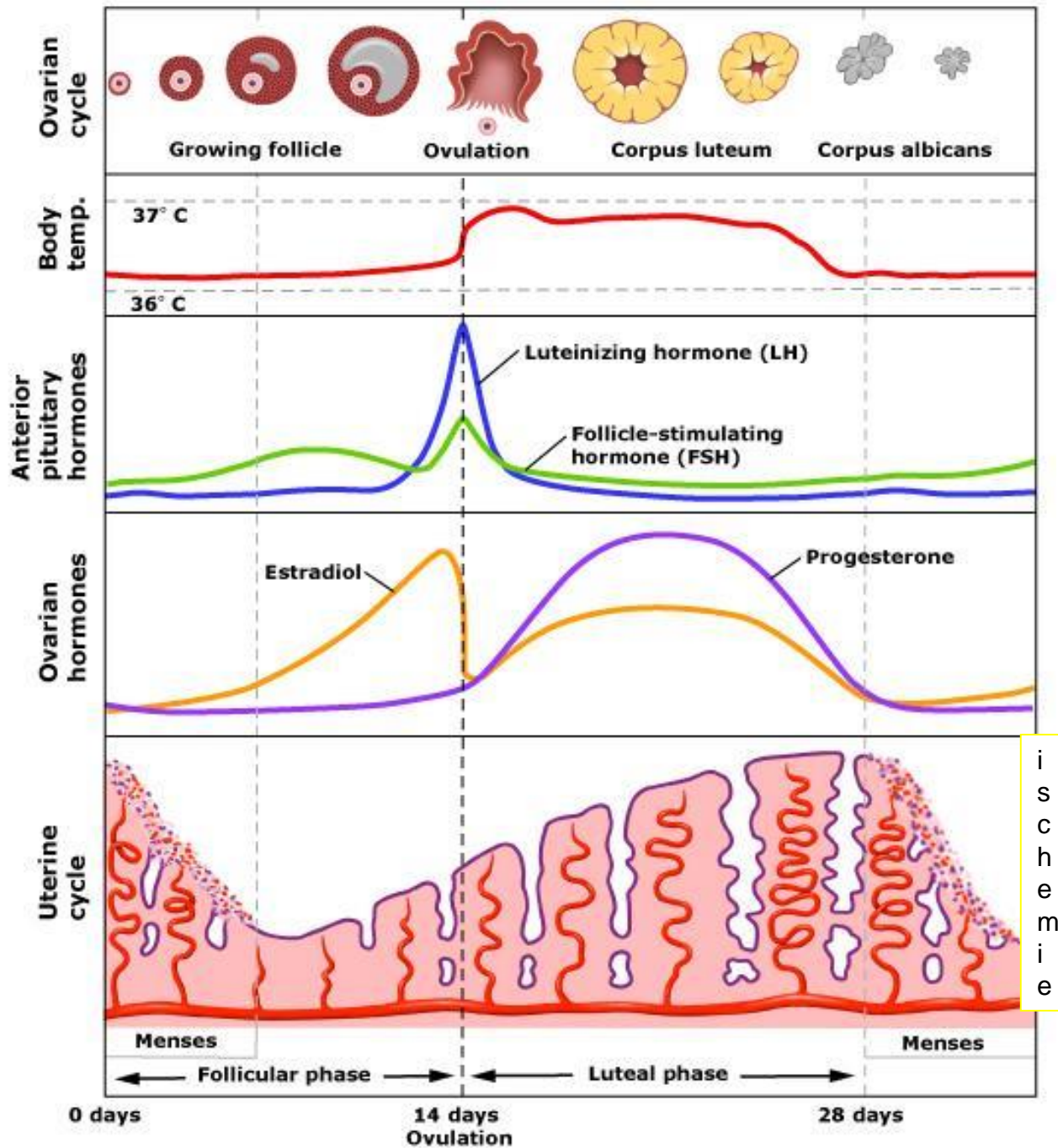
Hypothalamus

Adenohypophysis

Follicular cells

Corpus luteum





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Tuba uterina (tuba Fallopi, salpinx, oviduct)

12-15 cm

- Tunica mucosa
 - simple columnar epithelium
 - Ciliated cells
 - Nonciliated, peg cells
 - lamina propria
- Tunica muscularis
 - inner circular
 - outer longitudinal
- Tunica serosa
 - mesothelium
 - lamina propria serosae



infundibulum + fimbriae
ampulla - 2/3
isthmus - 1/3
pars intramuralis (pars uterina)

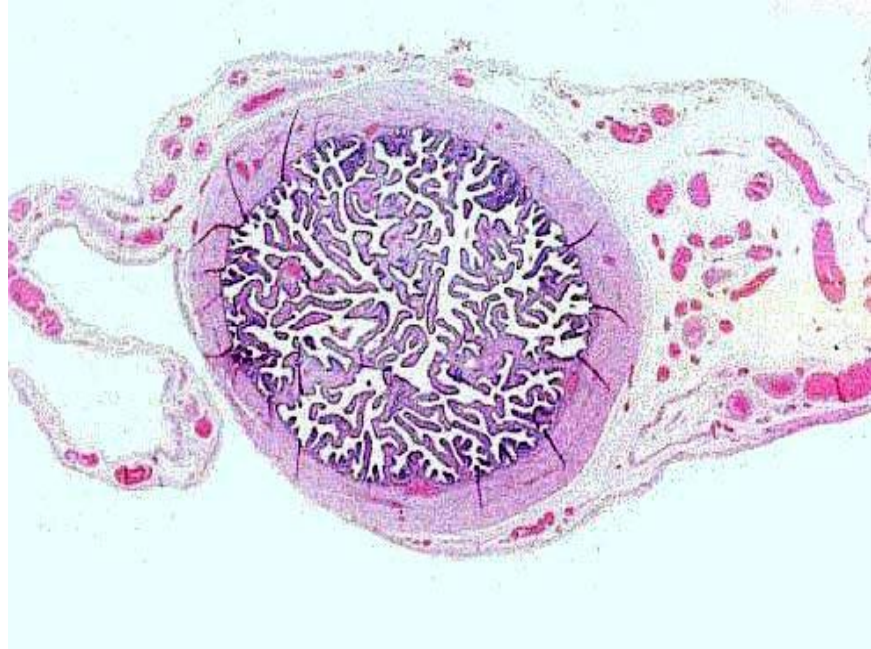
Tuba uterina

Isthmus

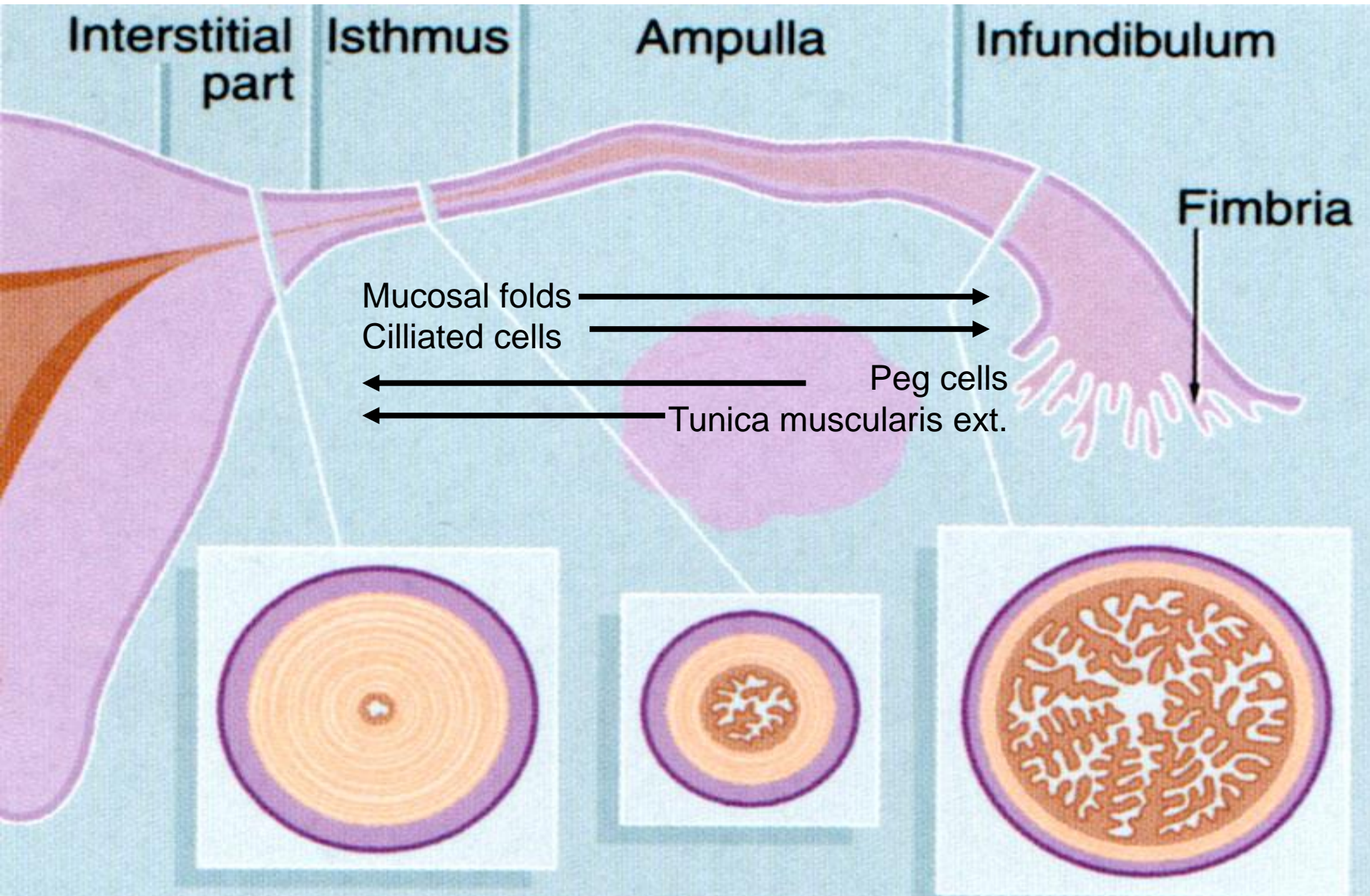
Ampulla

Infundibulum

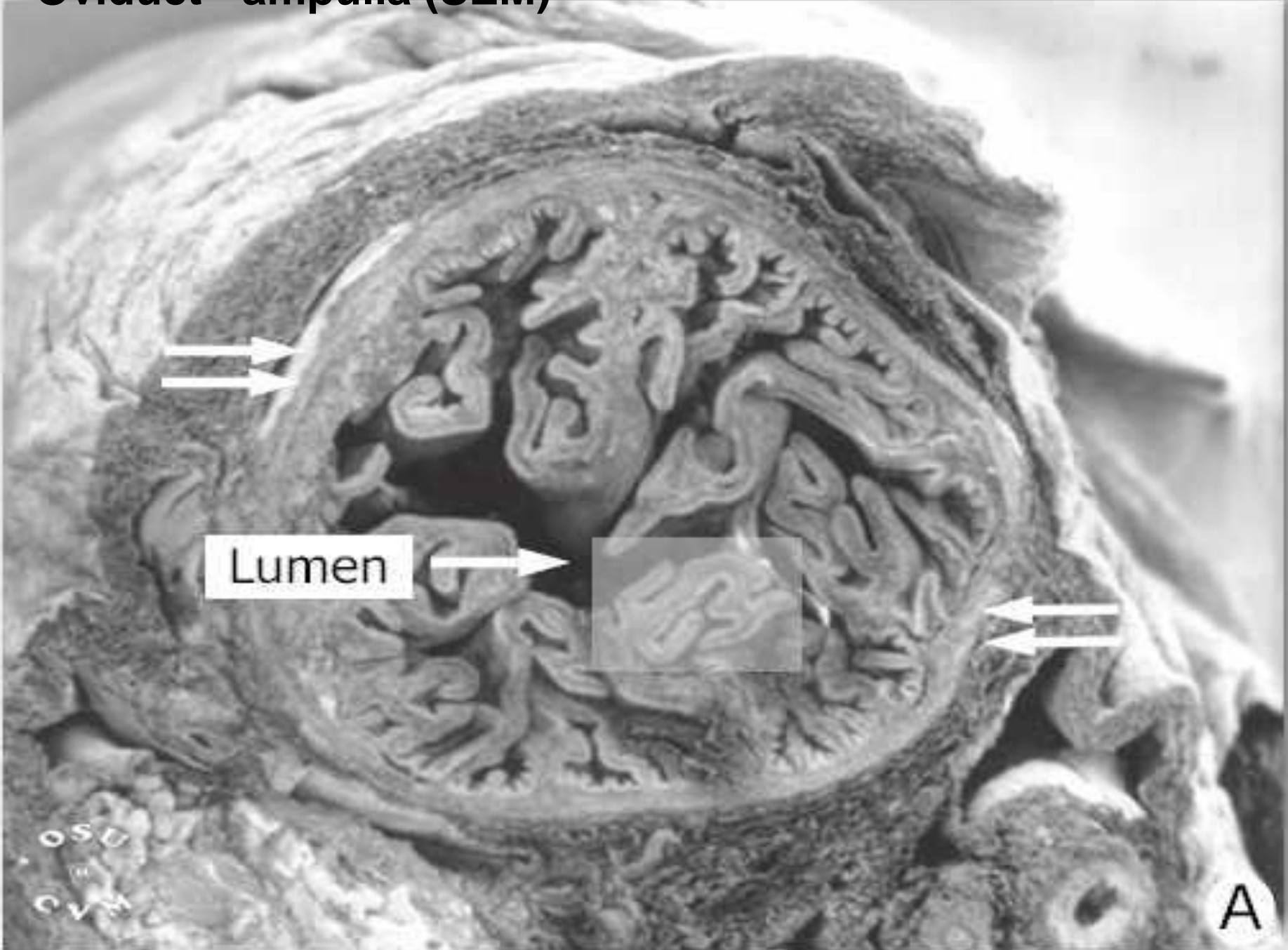
Fimbriae



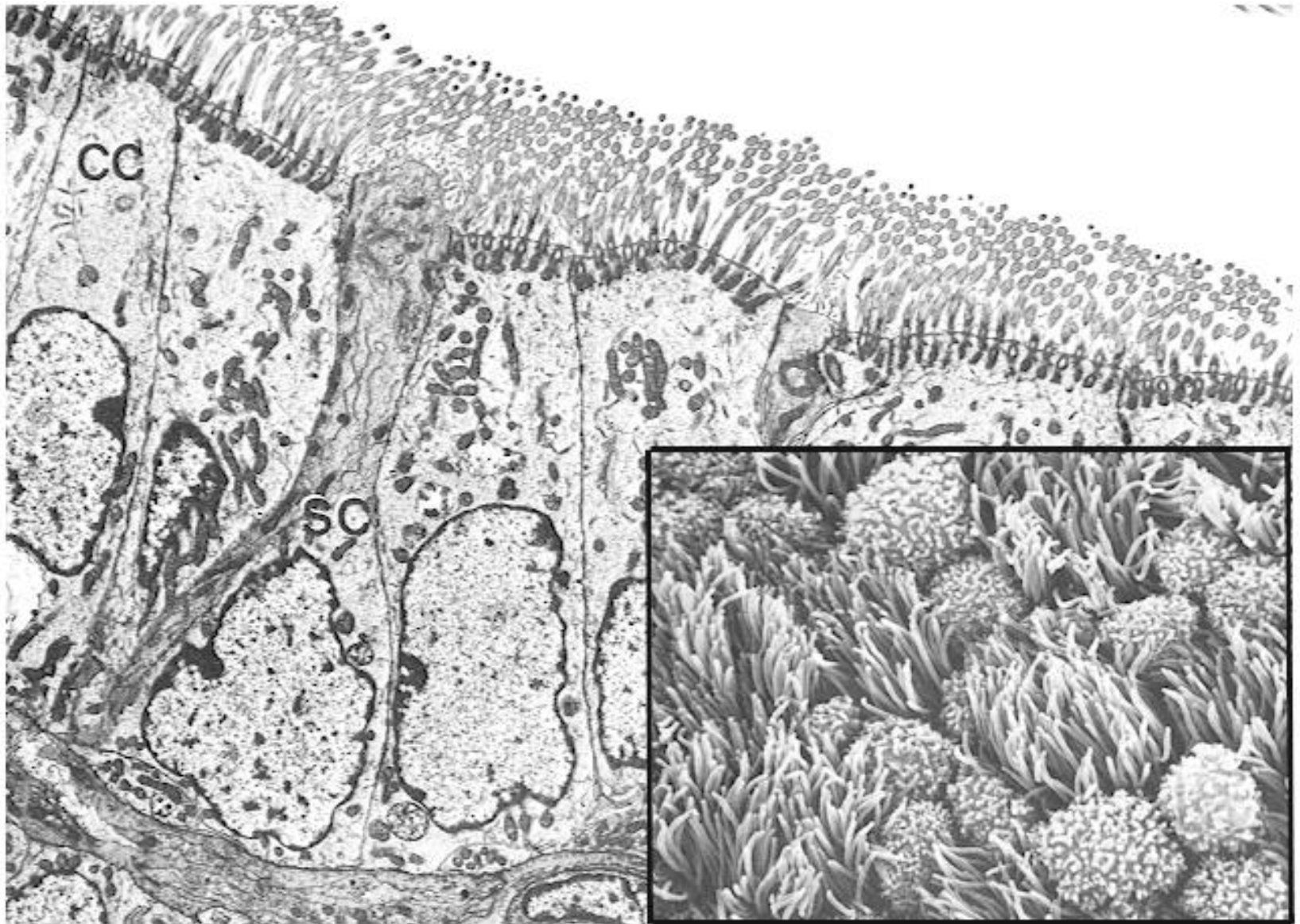
Regional differences in oviduct histology



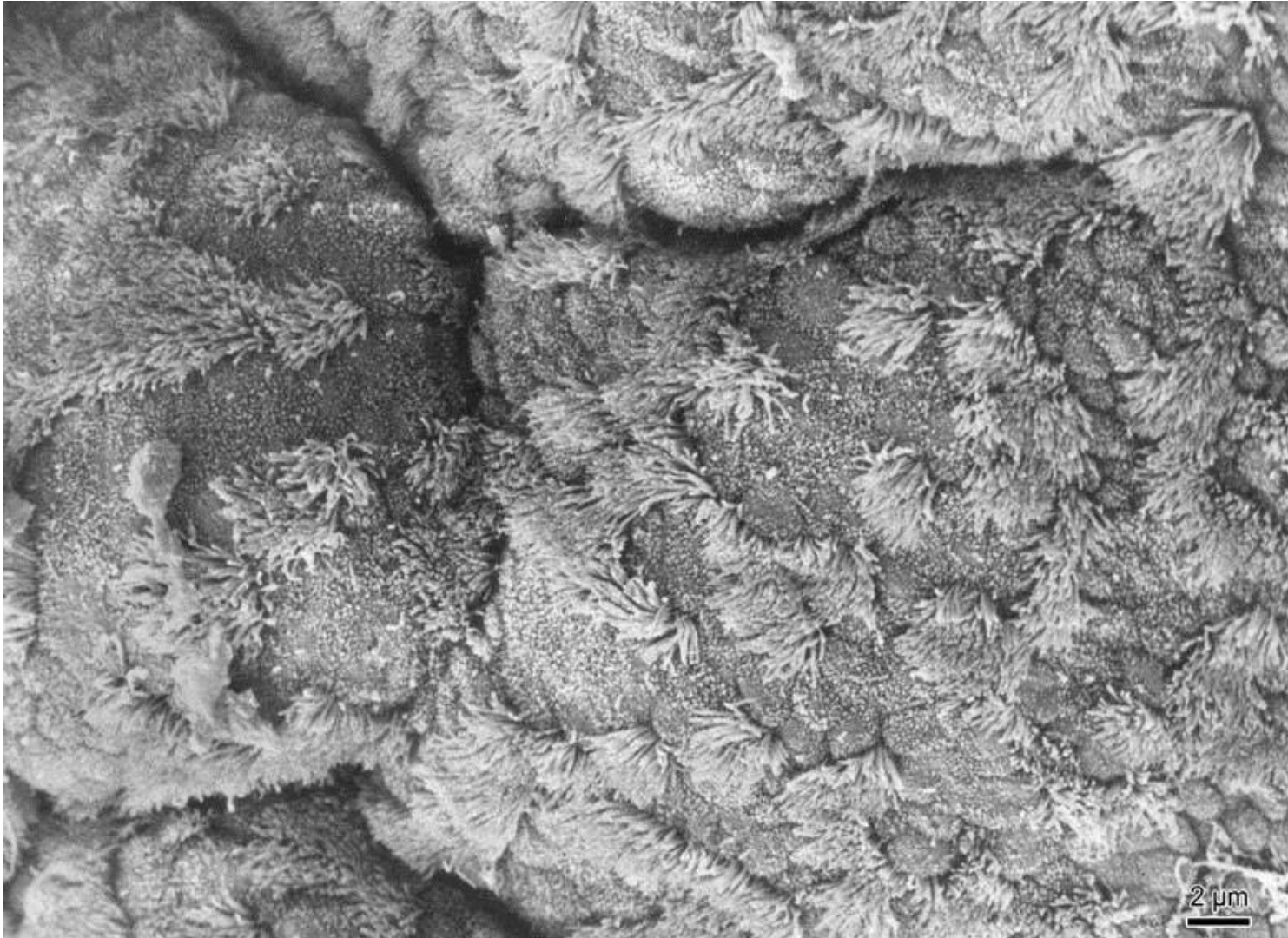
Oviduct - ampulla (SEM)



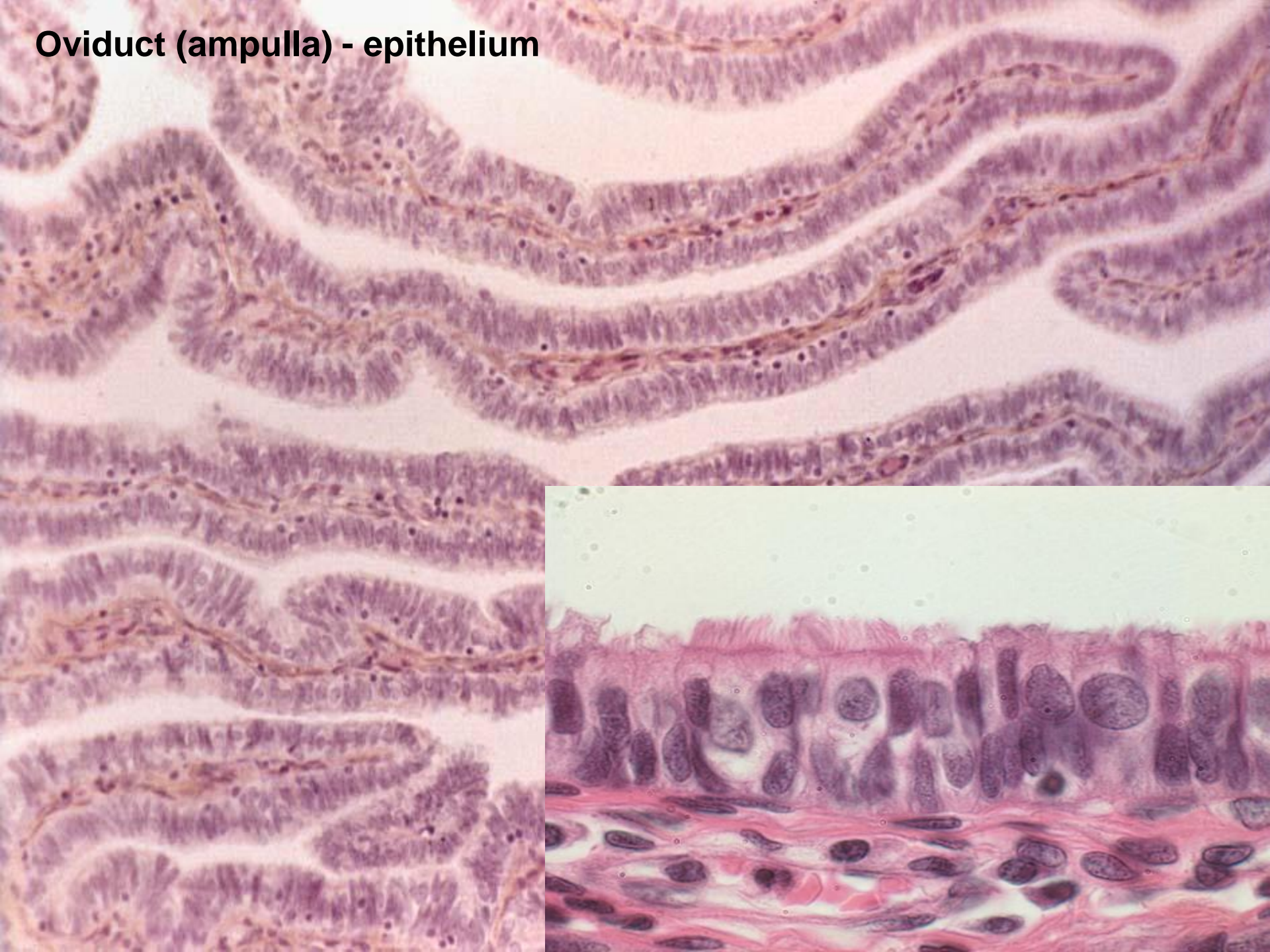
Tubar epithelium (TEM)



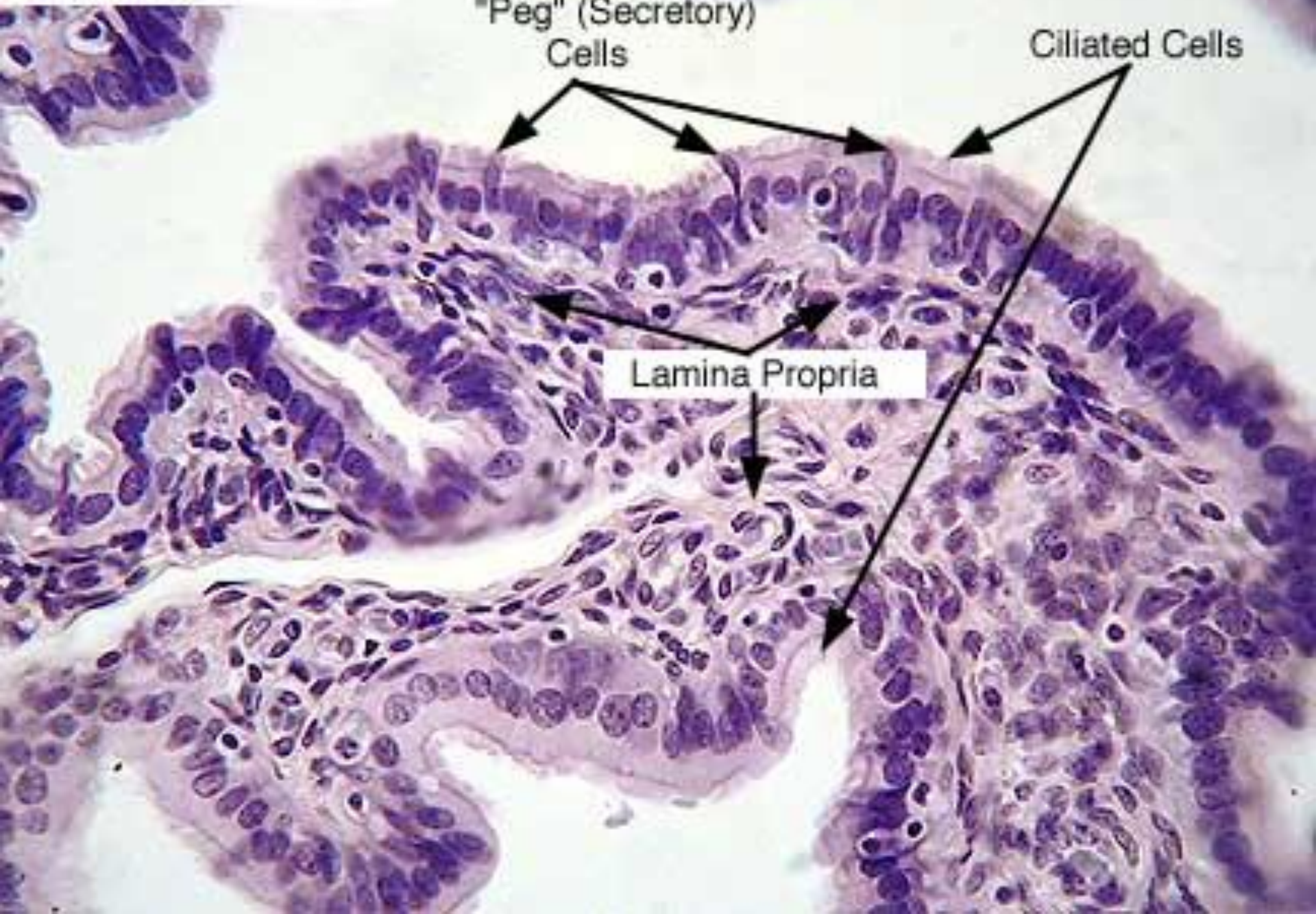
Tubar epithelium (SEM)



Oviduct (ampulla) - epithelium



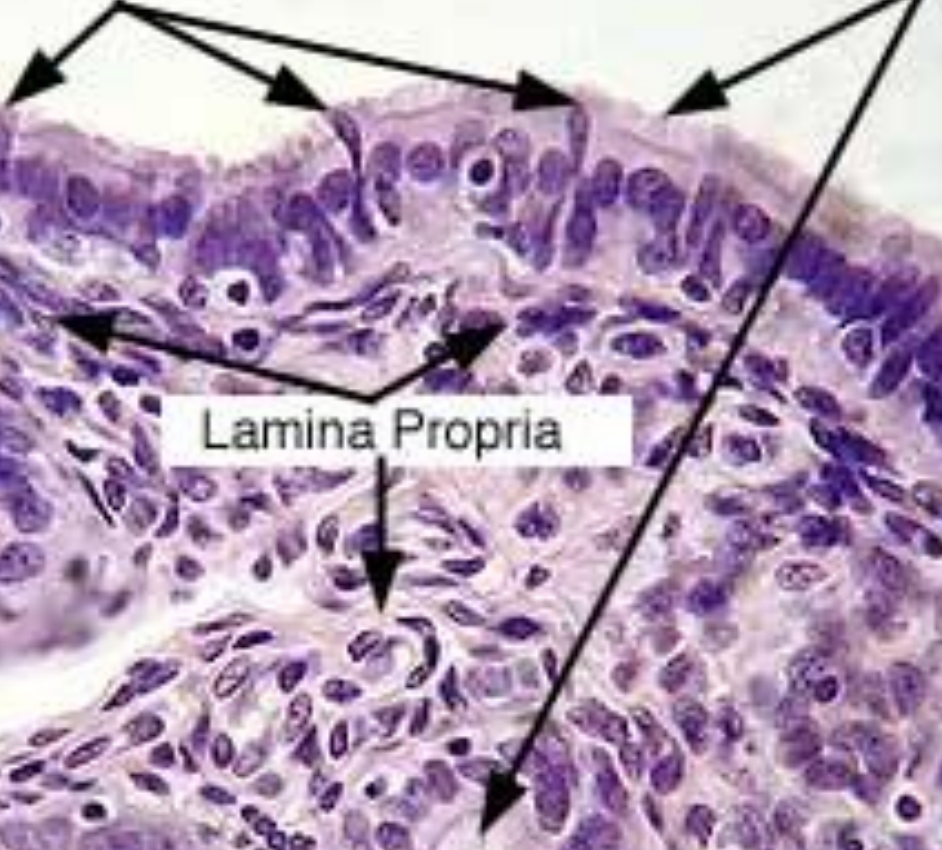
Ampulla of Oviduct



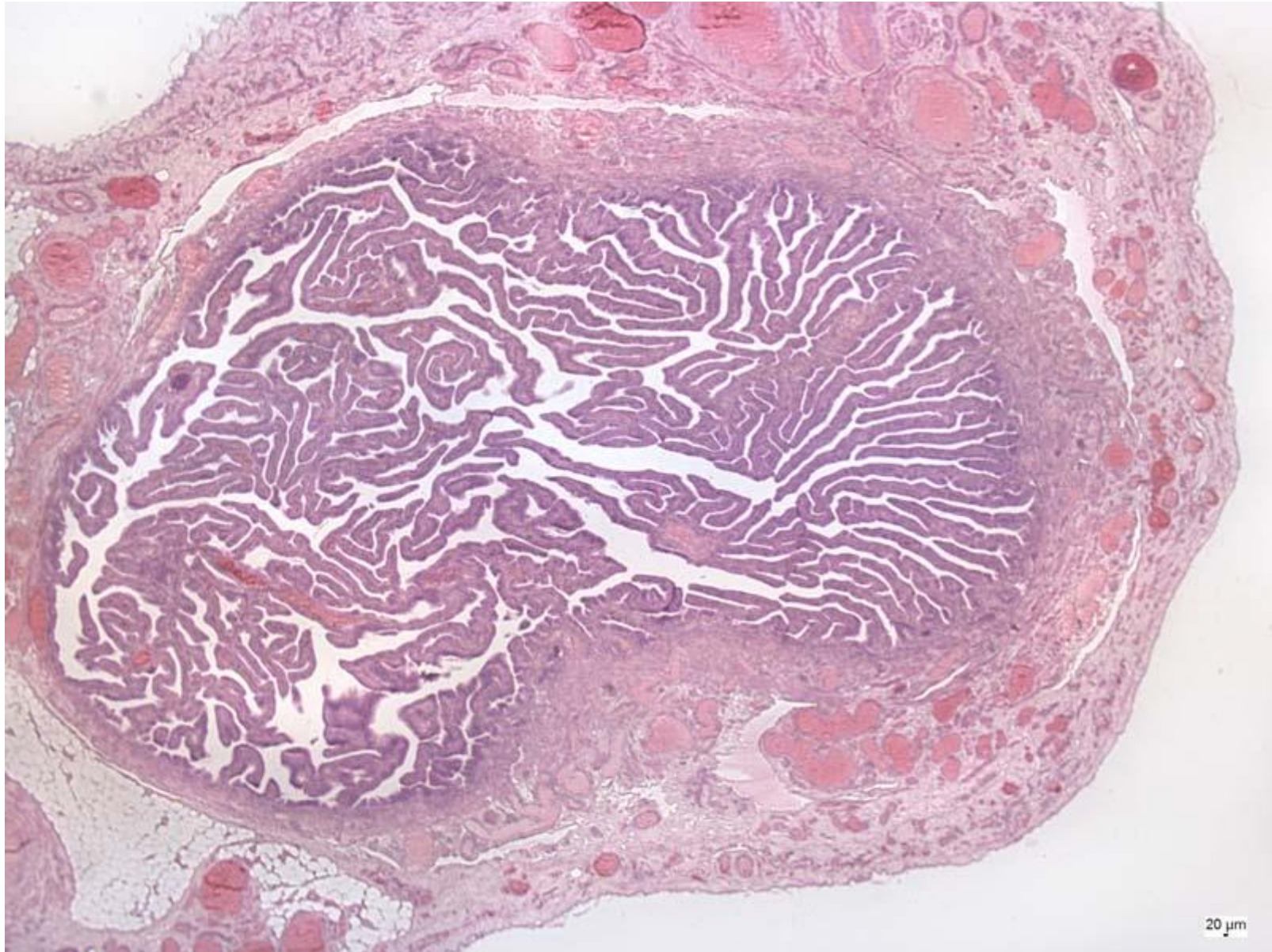
"Peg" (Secretory)
Cells

Ciliated Cells

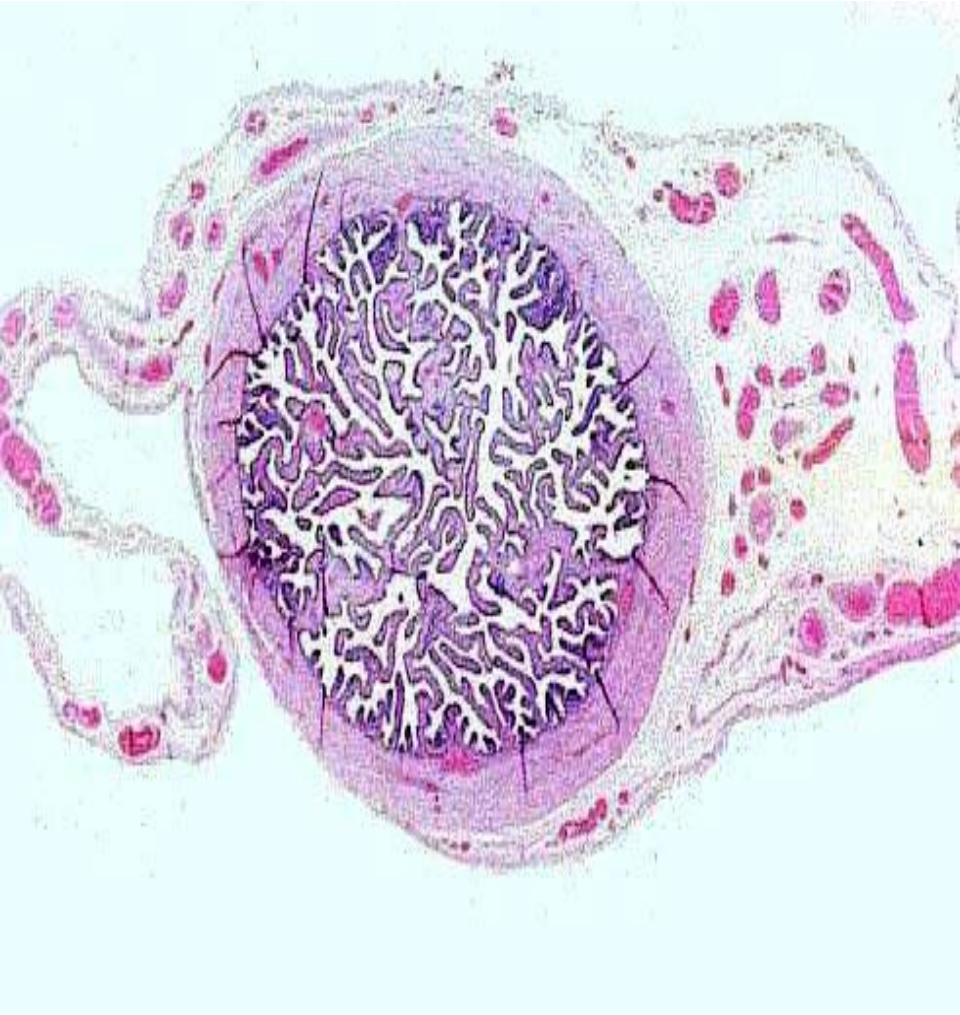
Lamina Propria



Tuba uterina - ampulla

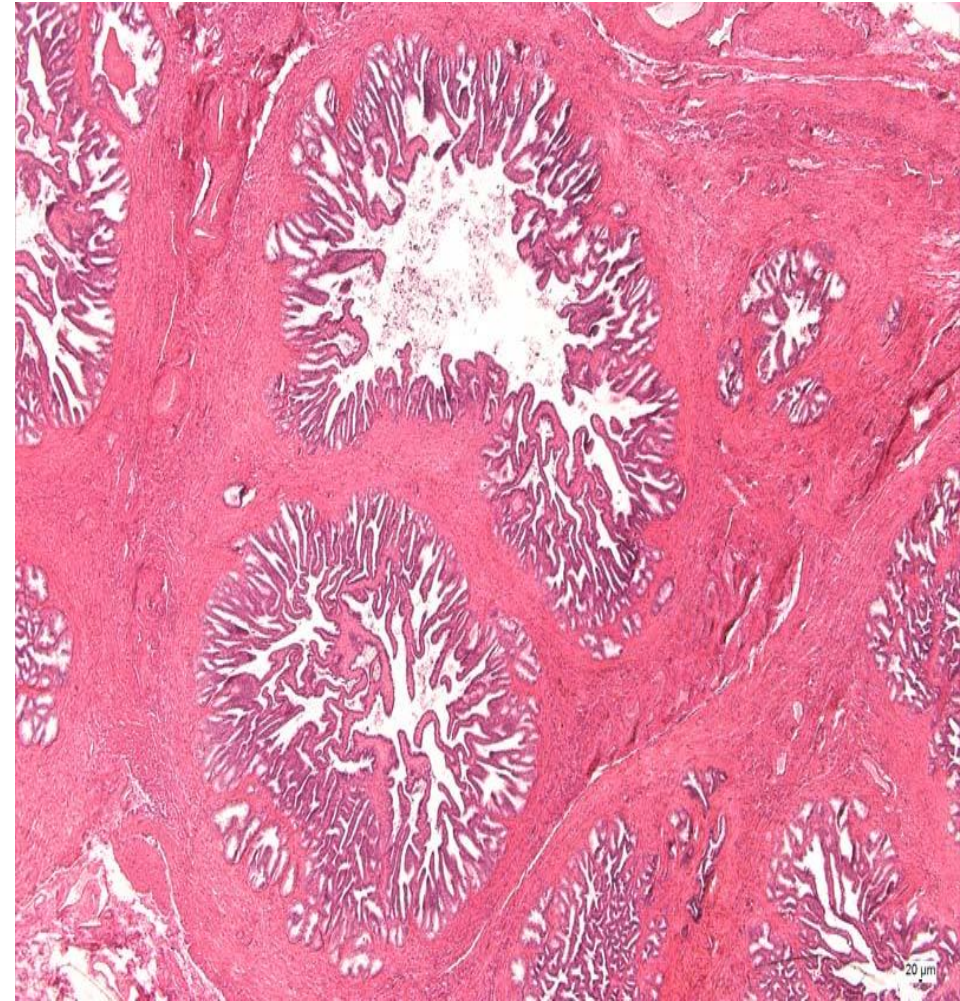


ampulla tubae uterinae

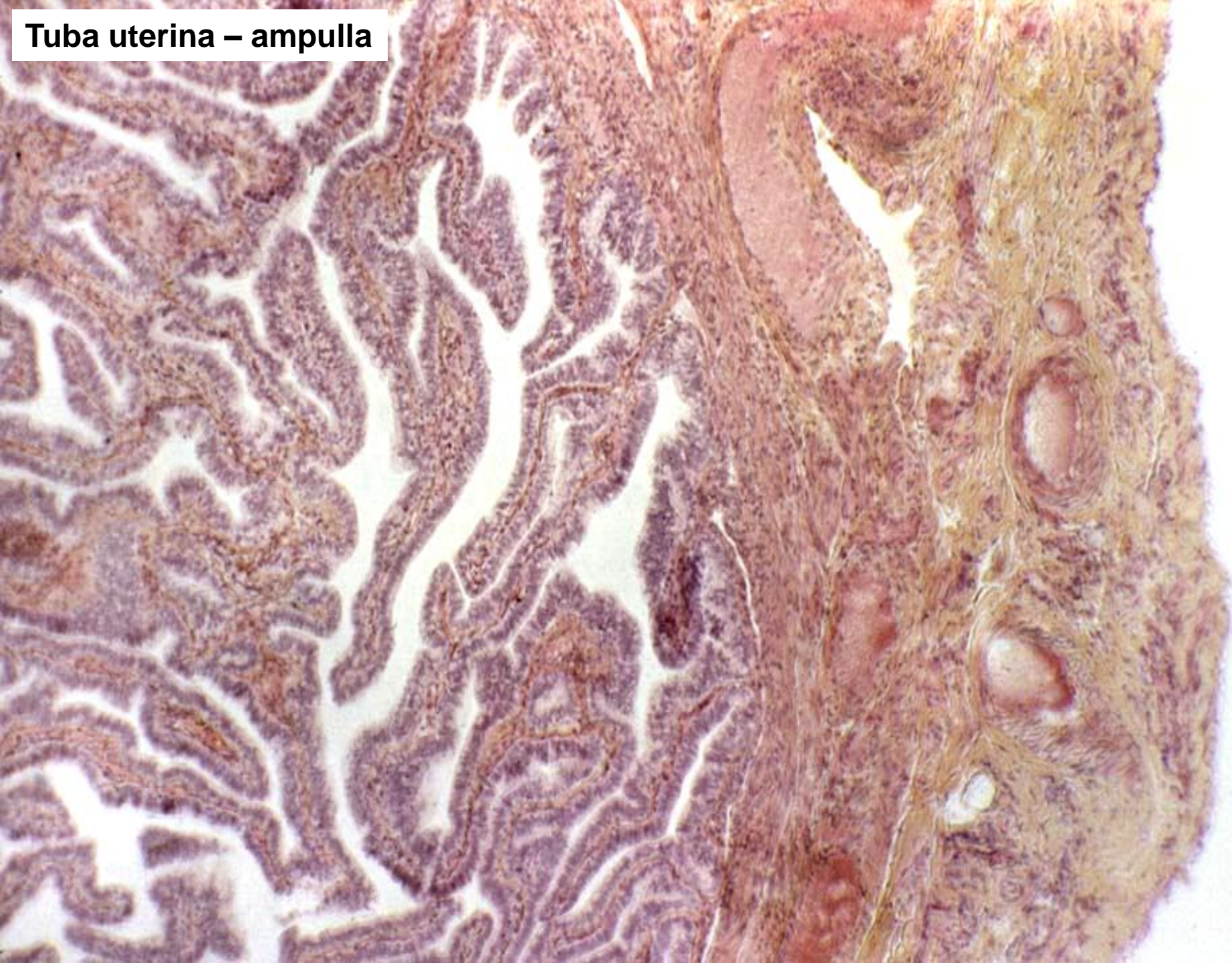


X

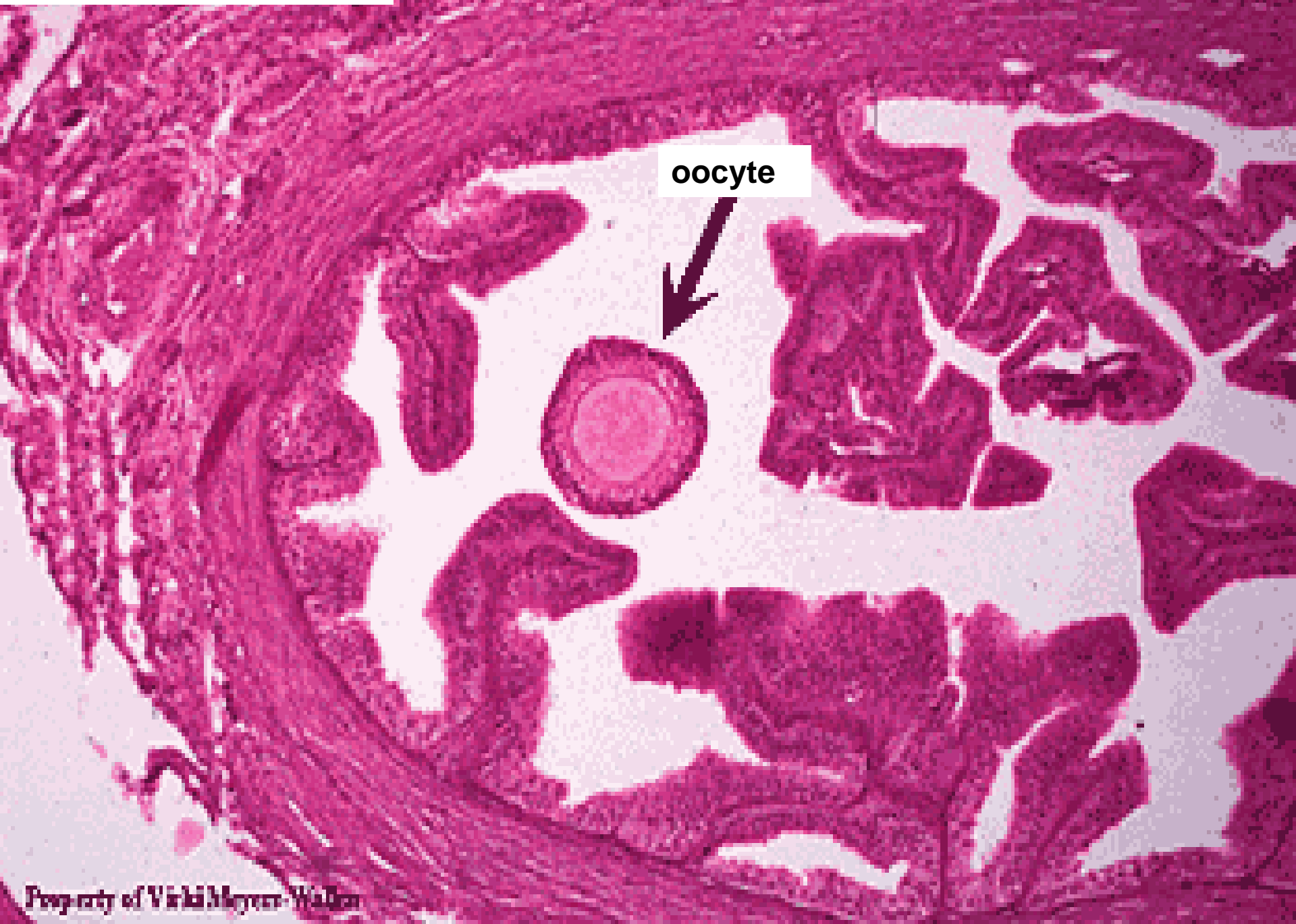
vesicula seminalis



Tuba uterina – ampulla

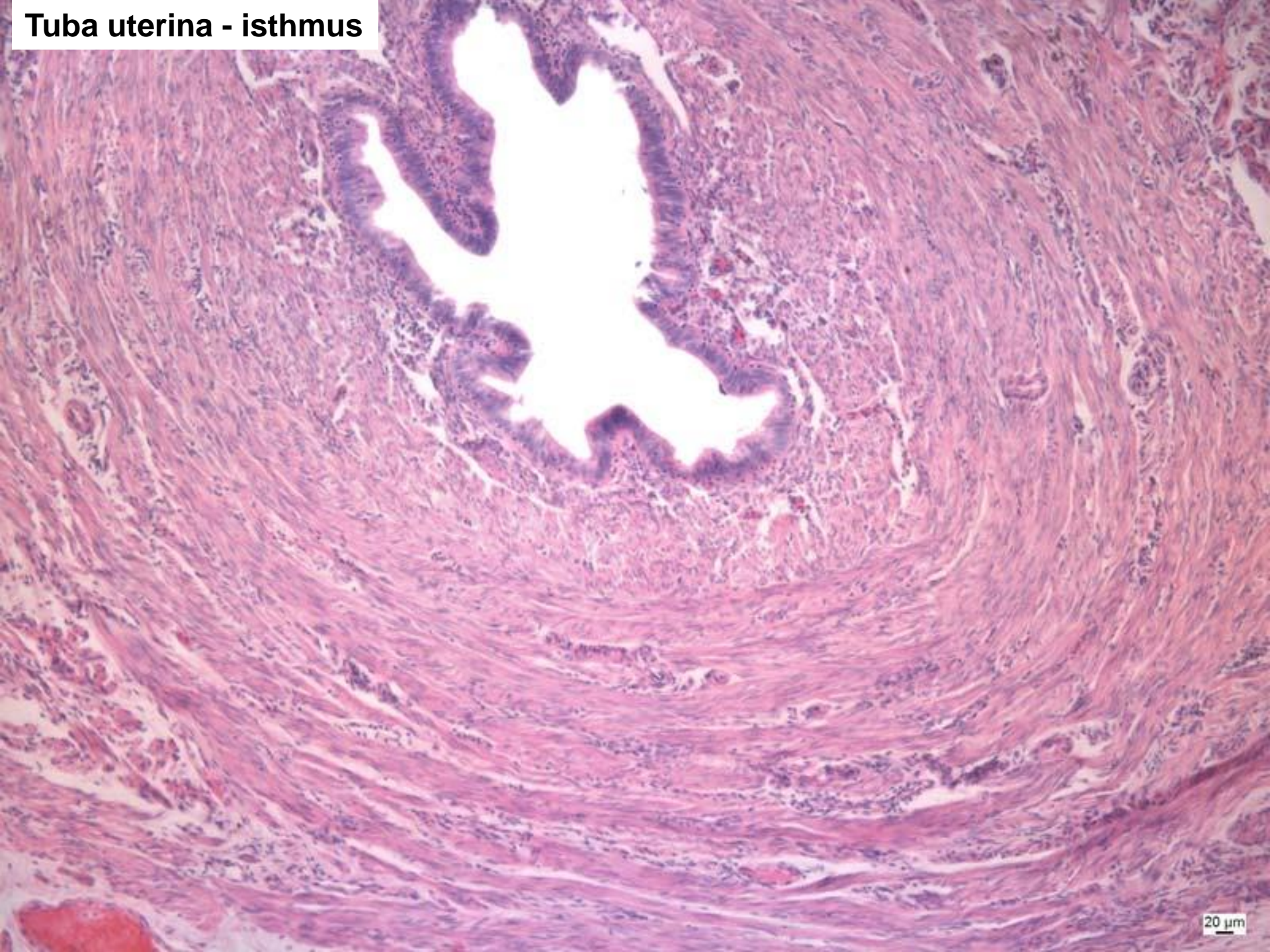


Tuba uterina – ampulla



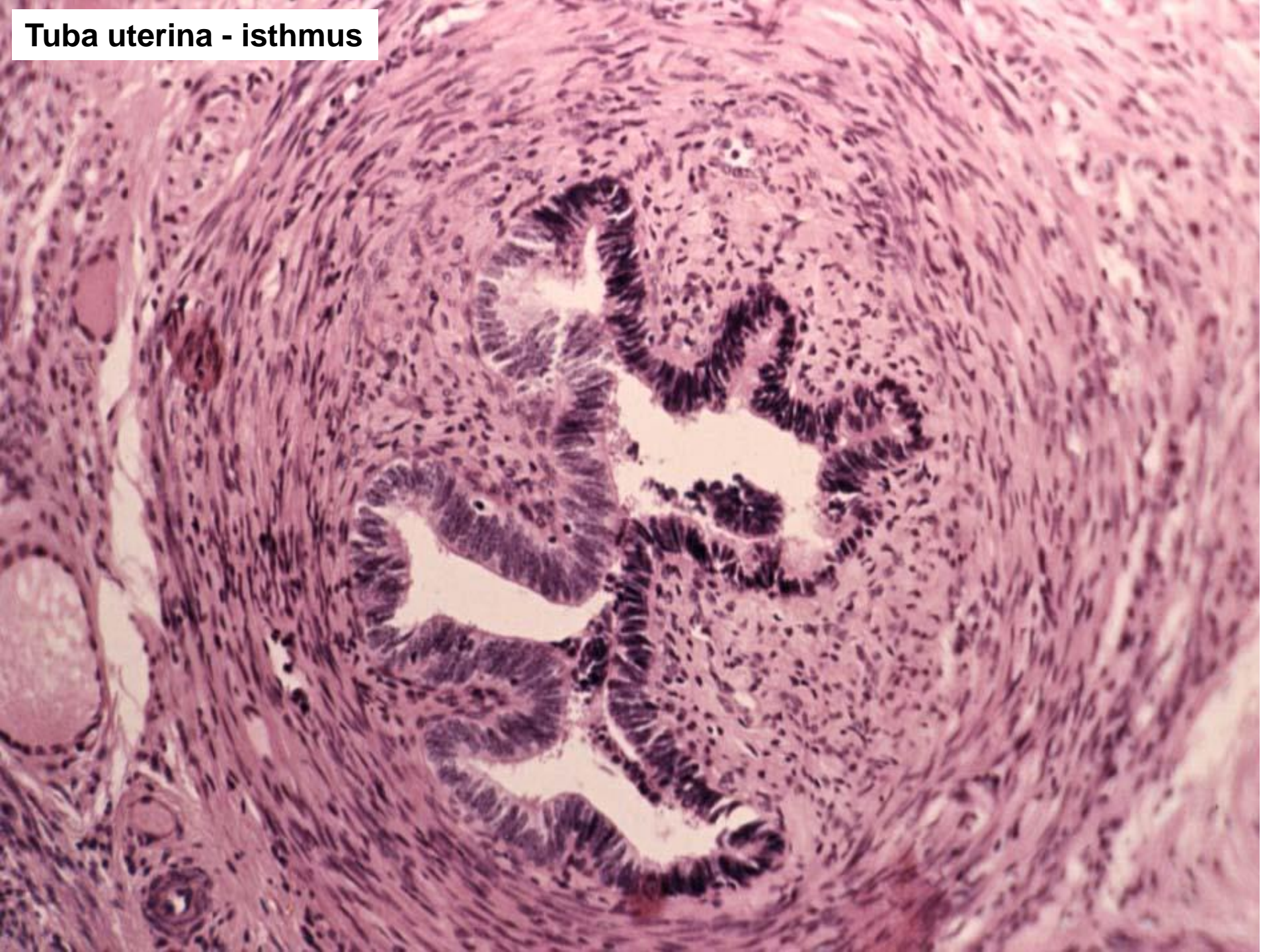
oocyte

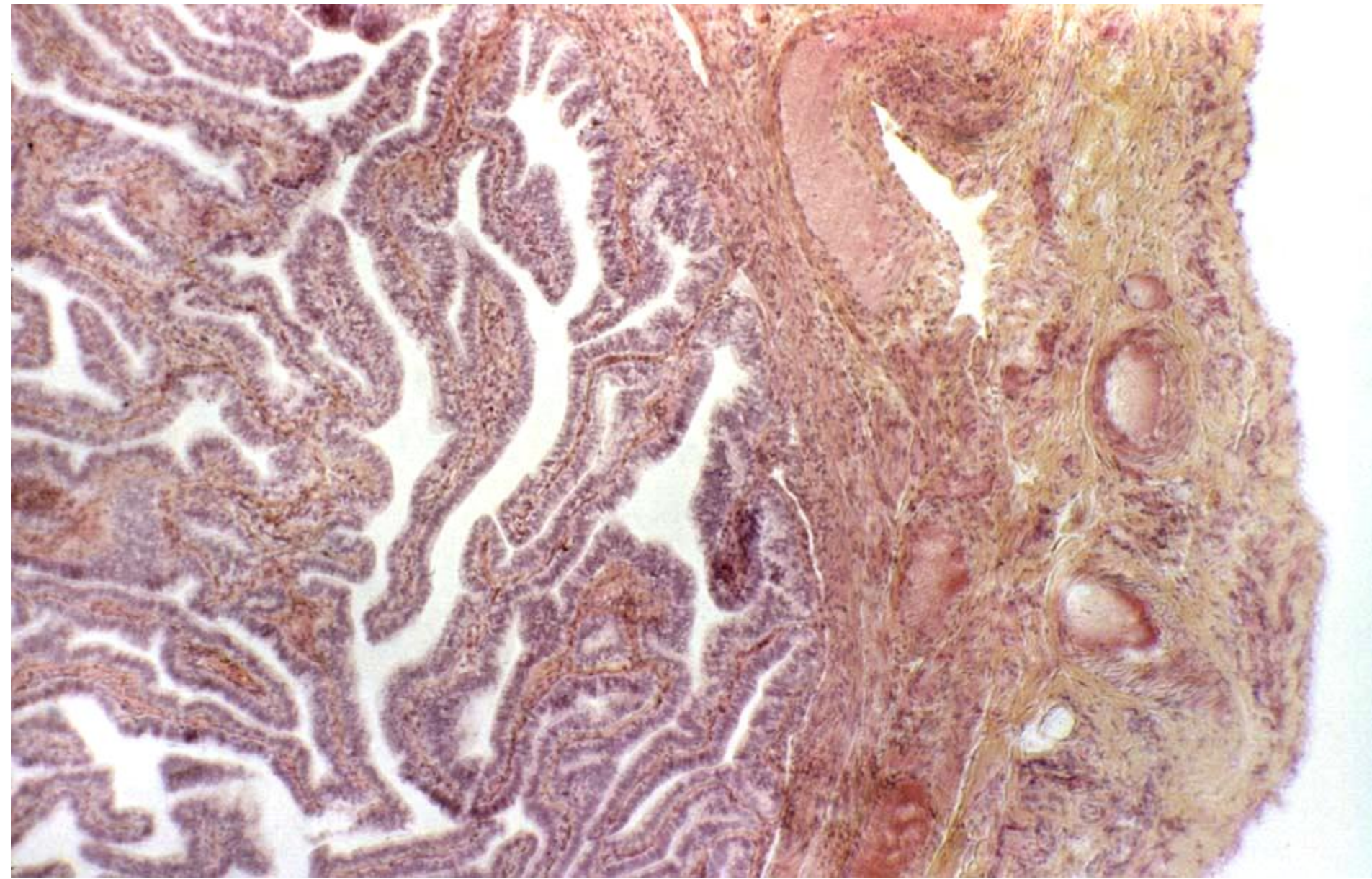
Tuba uterina - isthmus

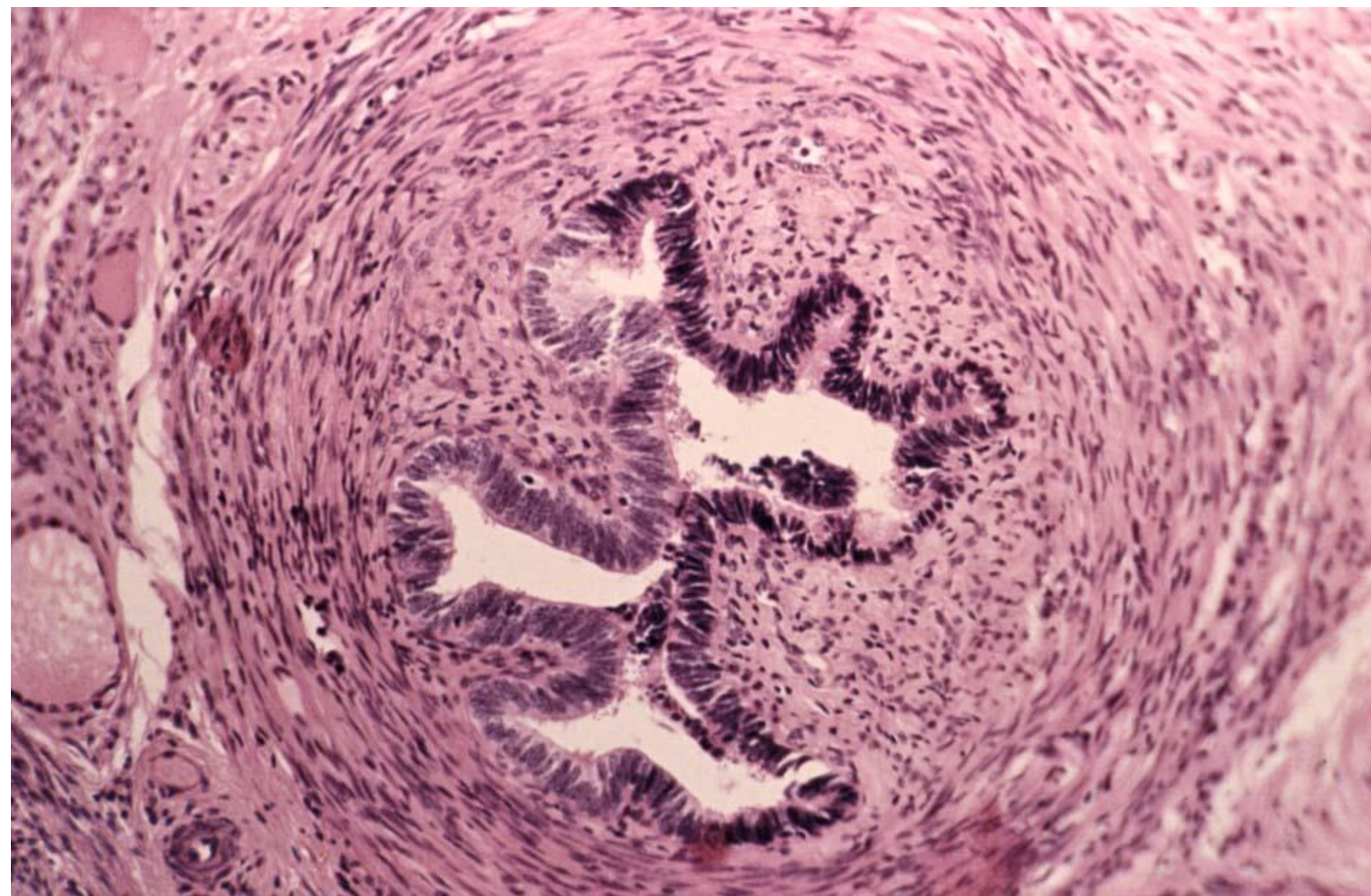


20 μ m

Tuba uterina - isthmus







Female reproductive system I

Slides

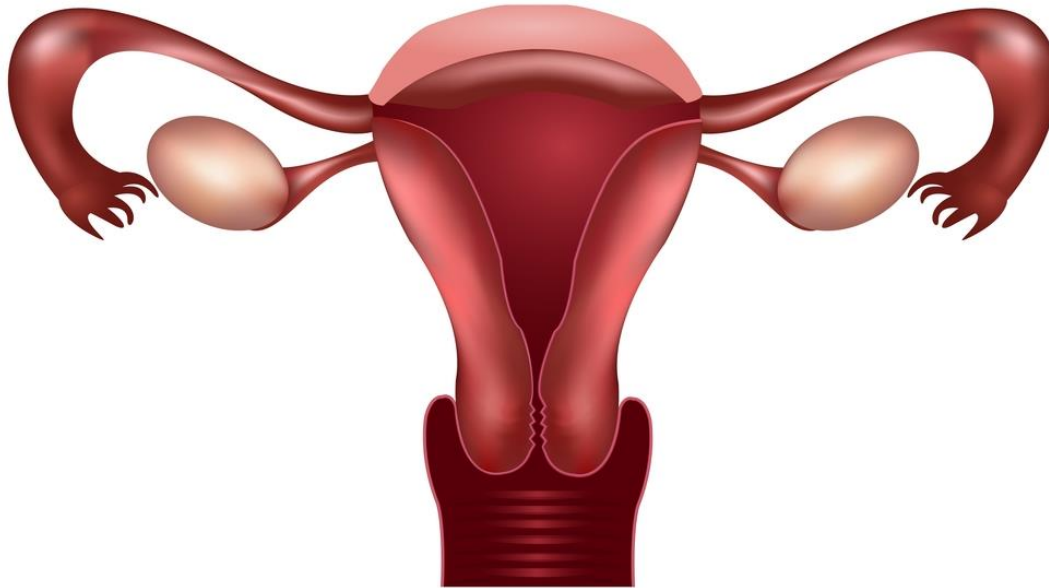
- 42. Ovarium (Homo, HE)
- 43. Ovarium (Felis domestica, HE)
- 44. Corpus luteum (HE)
- 45. Tuba uterina – pars ampullaris (HE)
- 46. Tuba uterina – pars isthmica (HE)

Atlas EM:

Primary follicle (1)

Oviduct - epithelium (26, 29, 30)

Female reproductive system II



Uterus

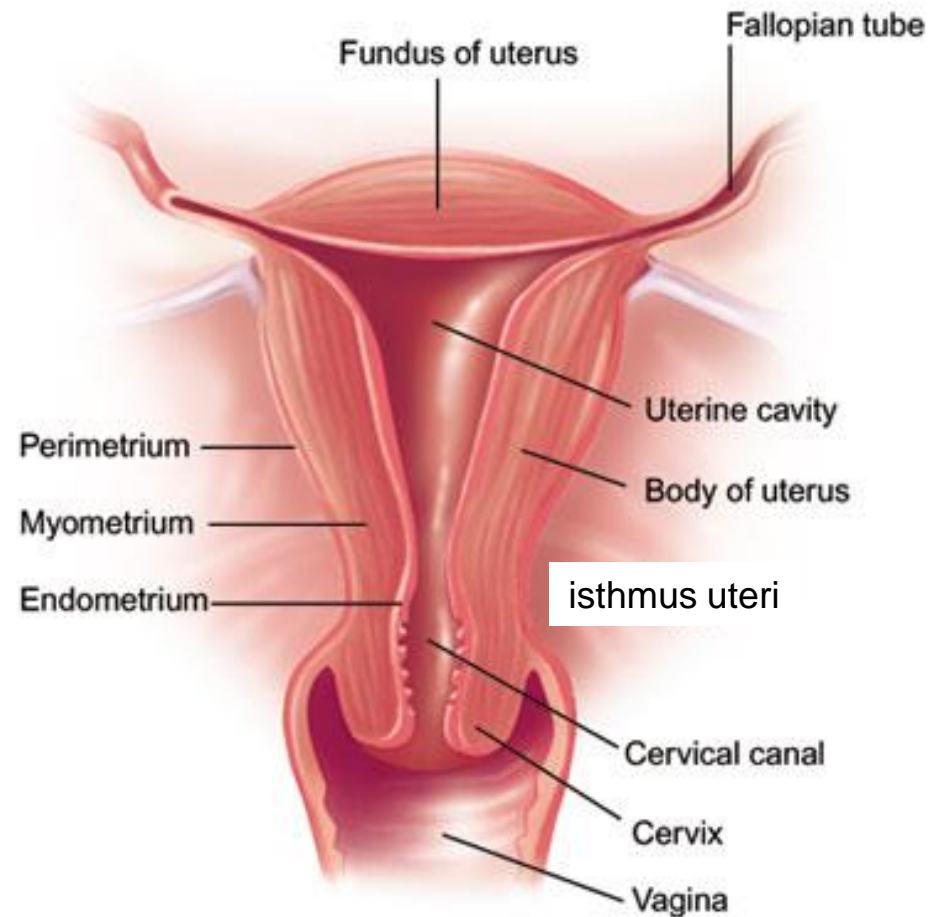
- Tunica mucosa (endometrium): epithelium (simple columnar), lamina propria = stroma + gll. uterinae

zona functionalis

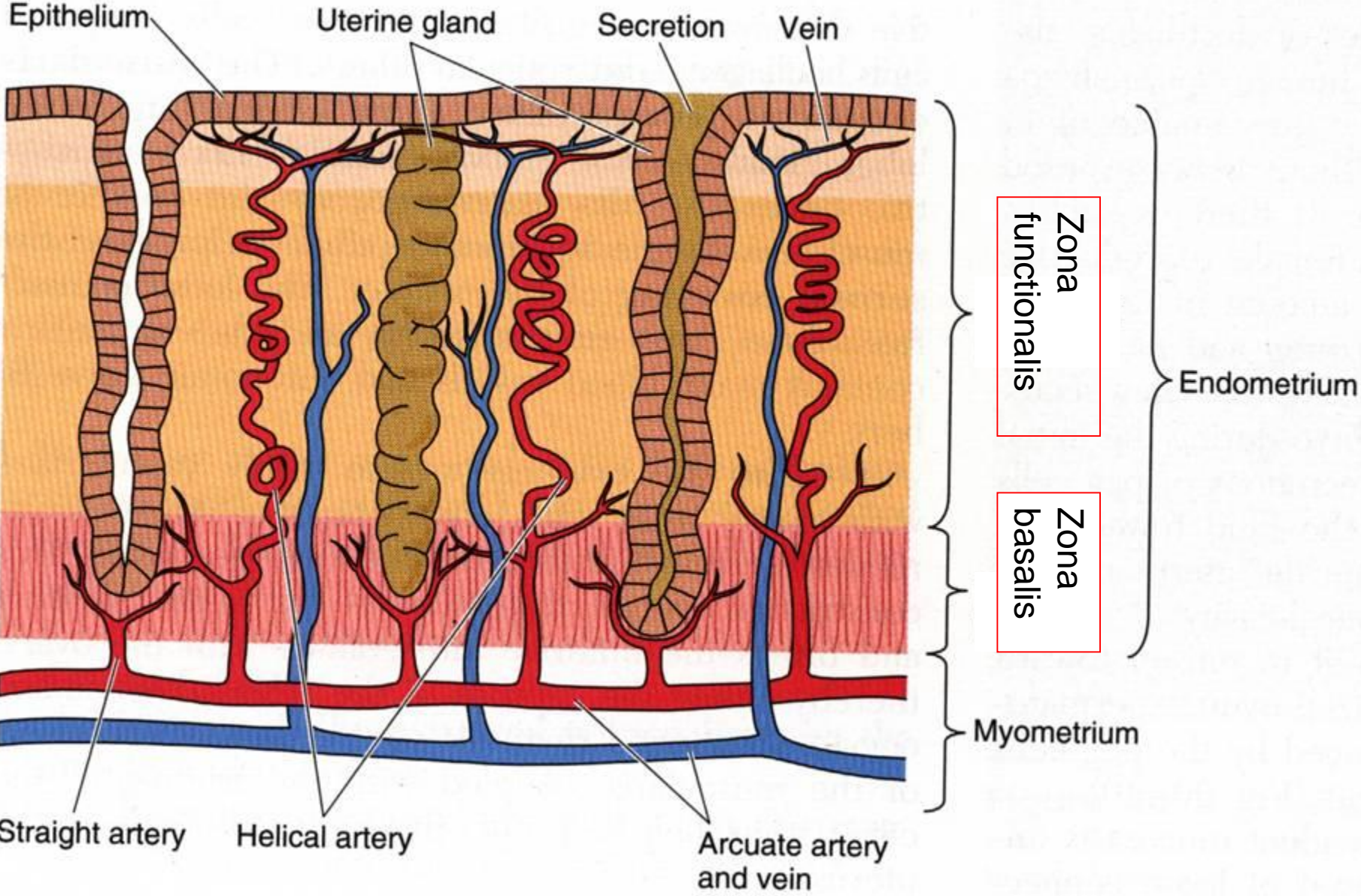
zona basalis

- Tunica muscularis ext. (myometrium) spiral smooth muscle fibers

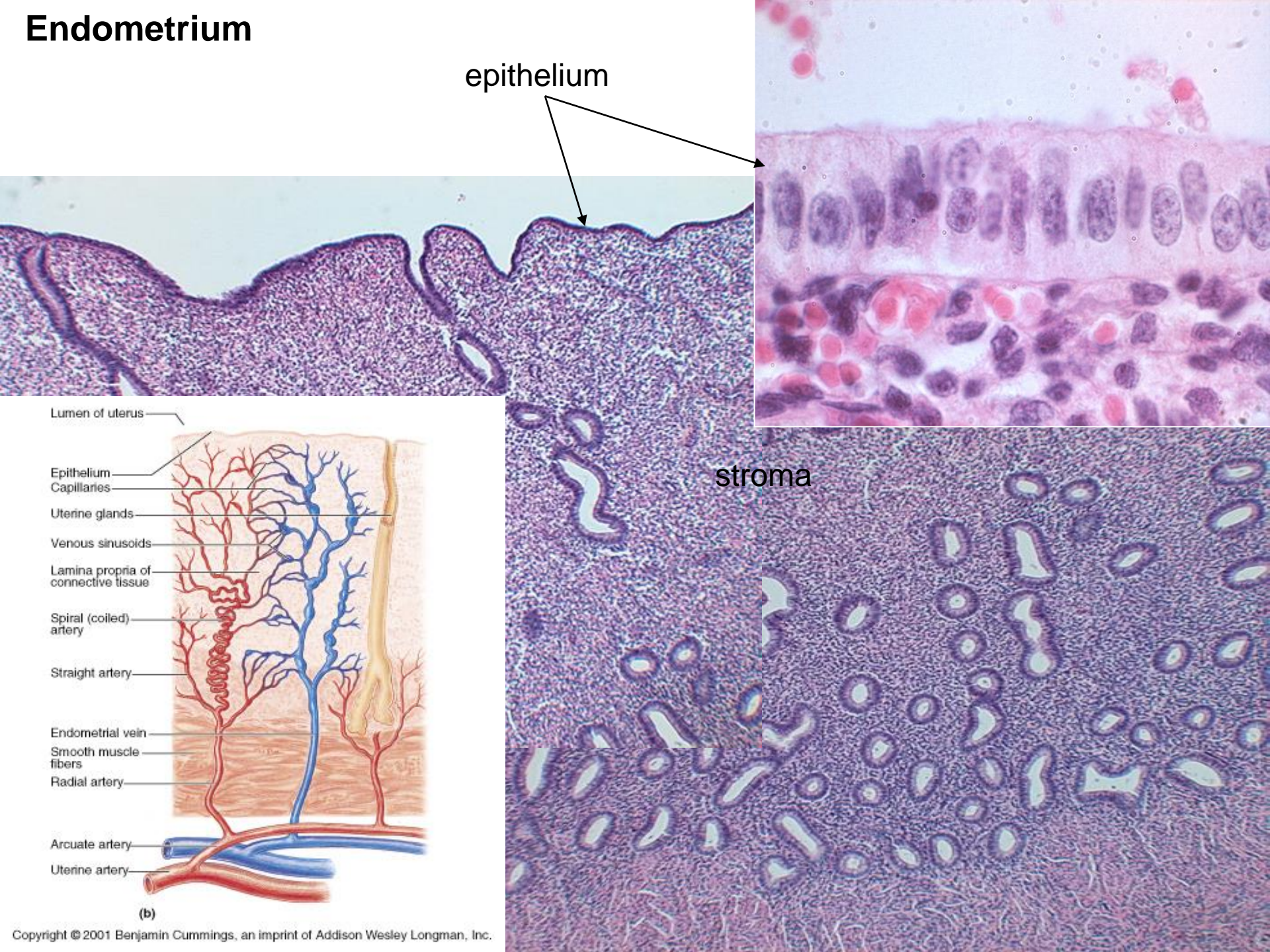
- Tunica serosa (perimetrium)



ENDOMETRIUM

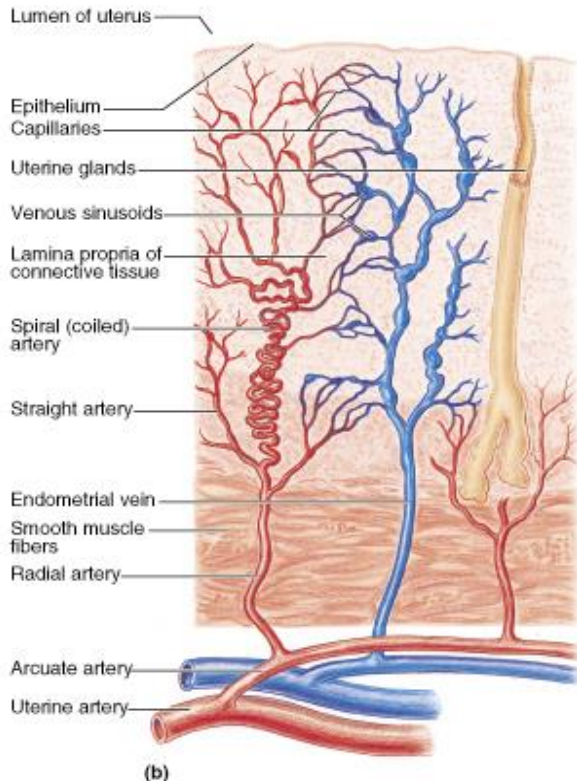


Endometrium

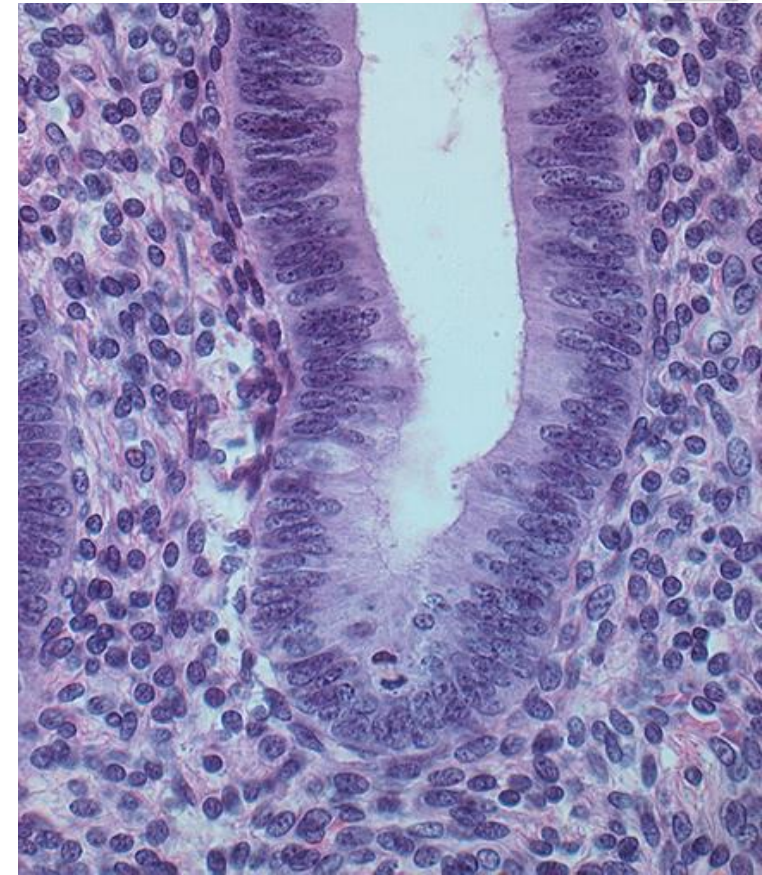
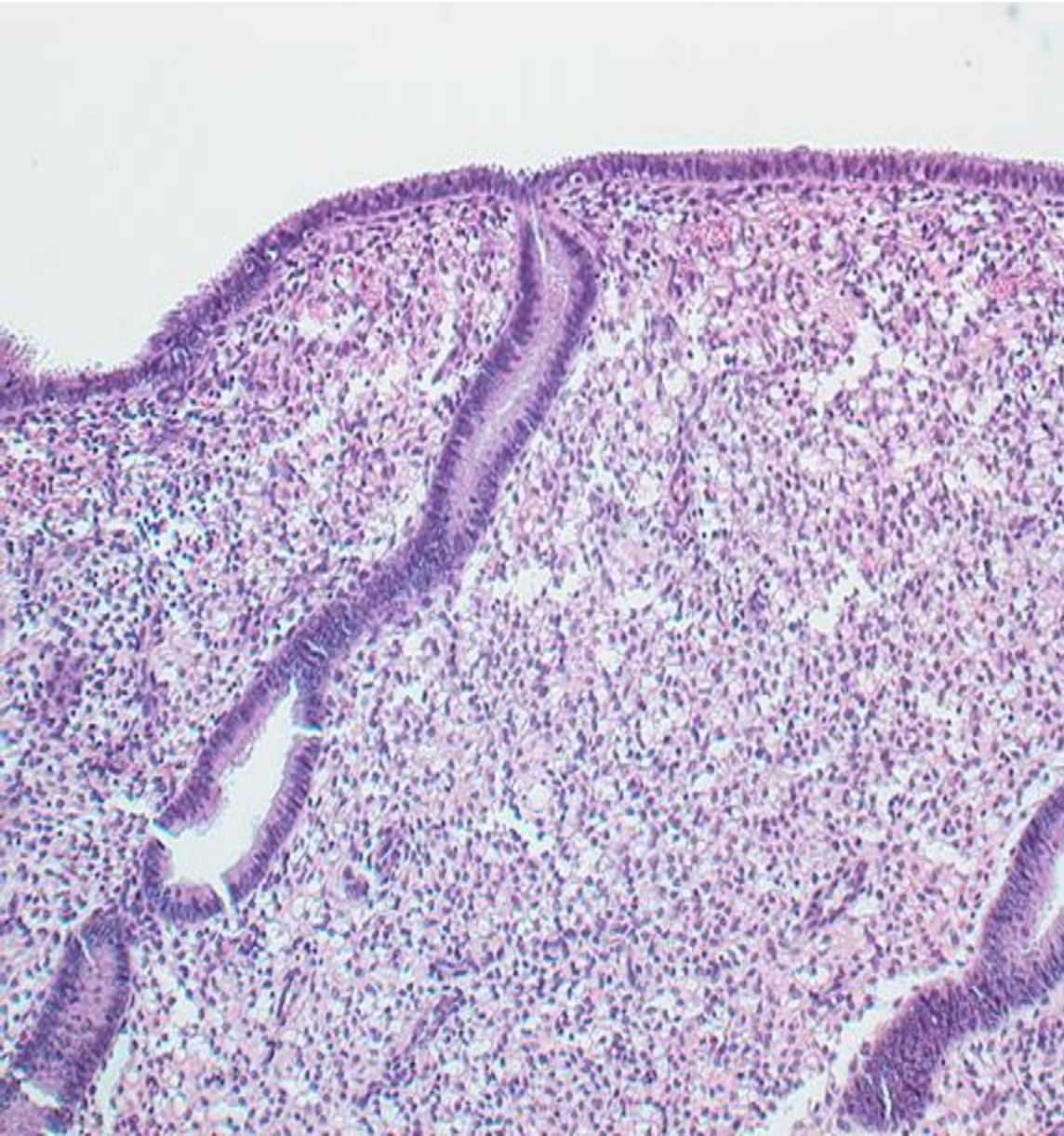


epithelium

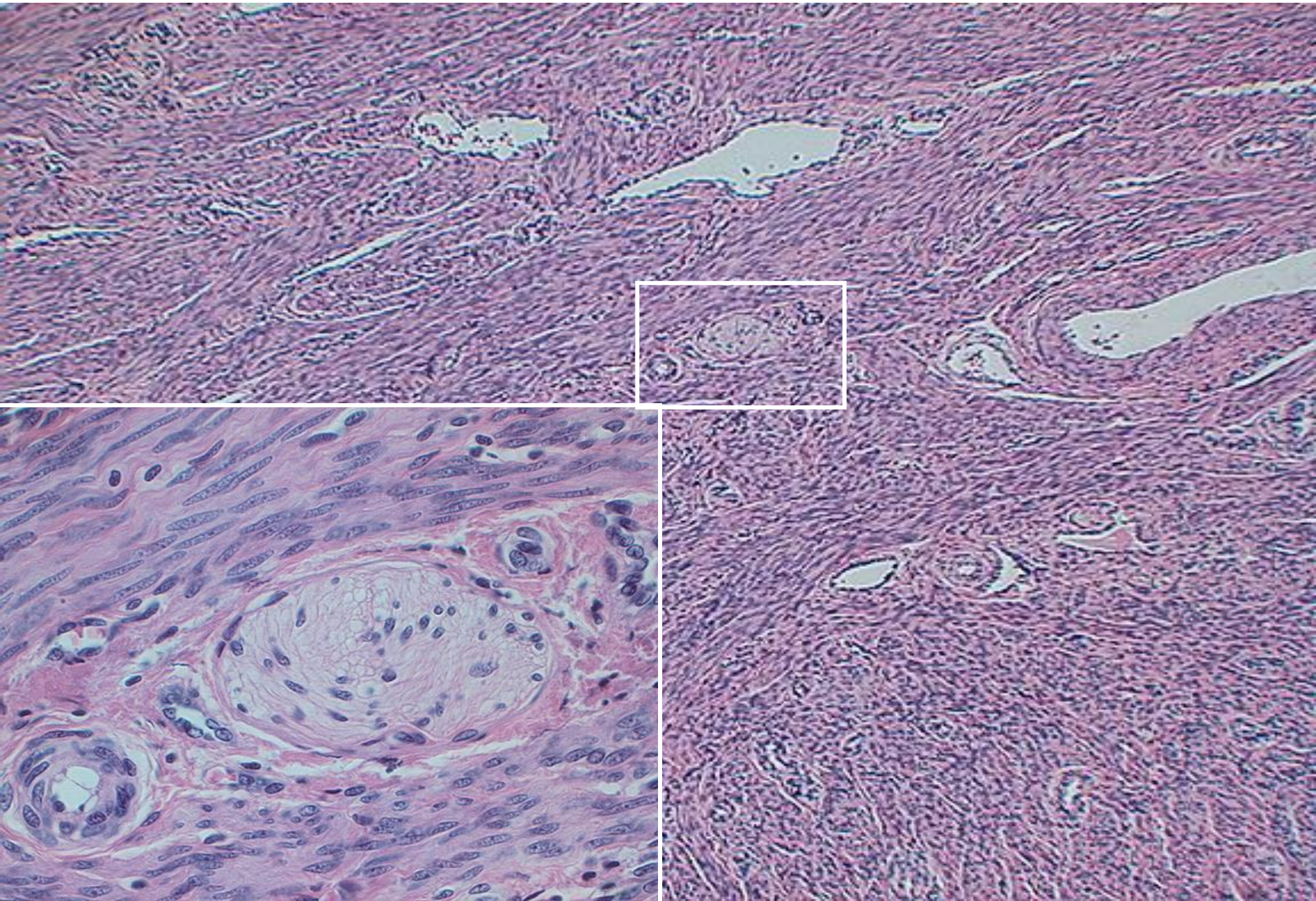
stroma



Uterus (proliferation phase
- gl. uterinae

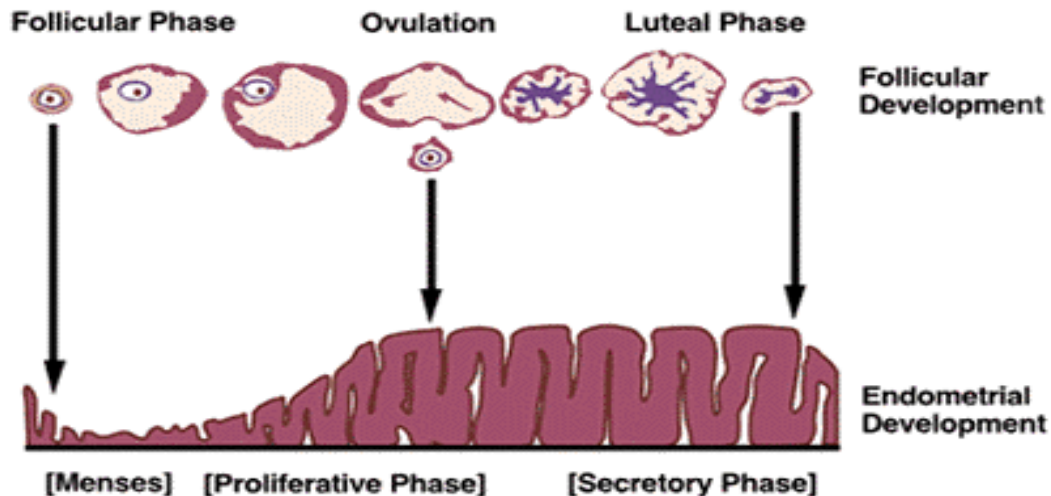


Myometrium



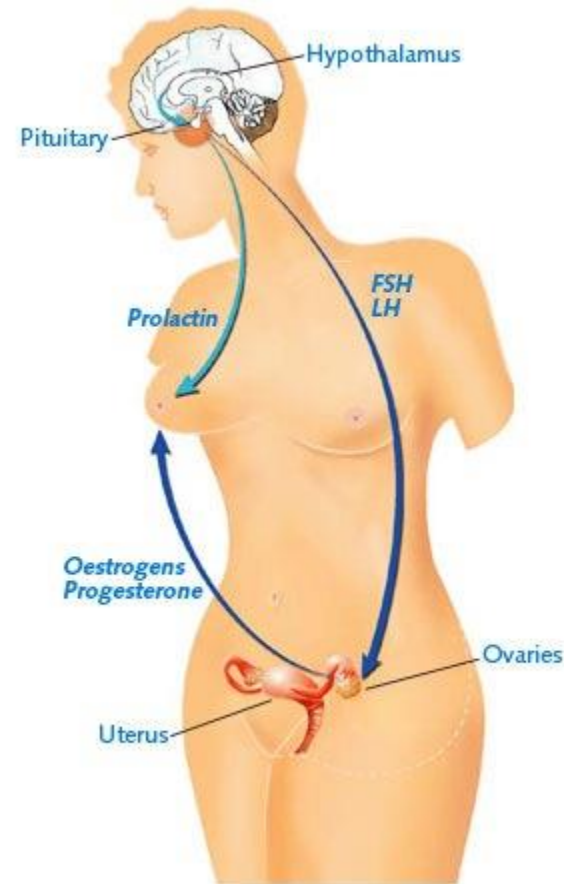
Menstrual cycle

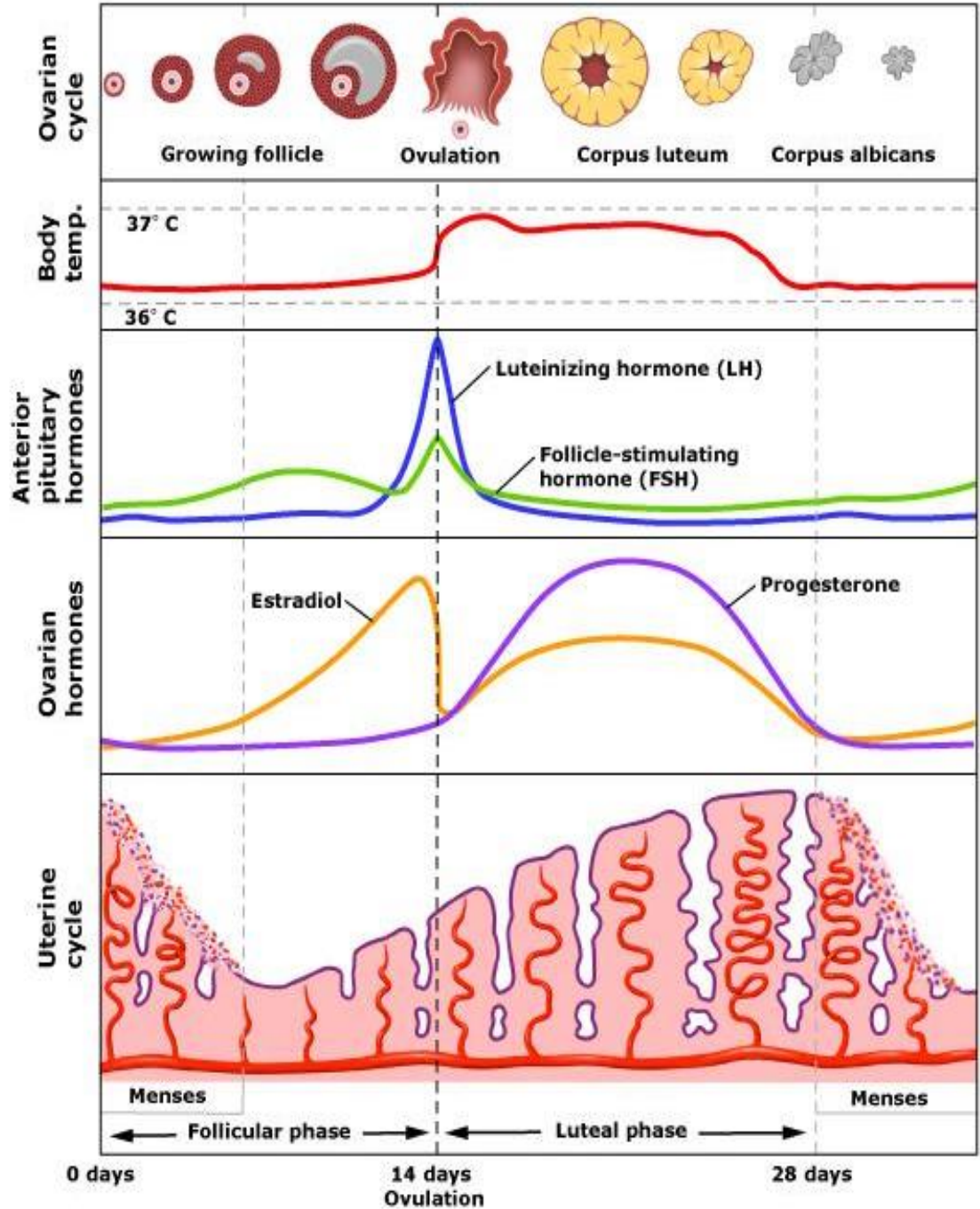
- Menstrual phase (Day 1. – 4.)
- Proliferative phase (Day 5. – 15.)
- Secretory phase (Day 16. – 27.)
- Ischemic phase (Day 28.)

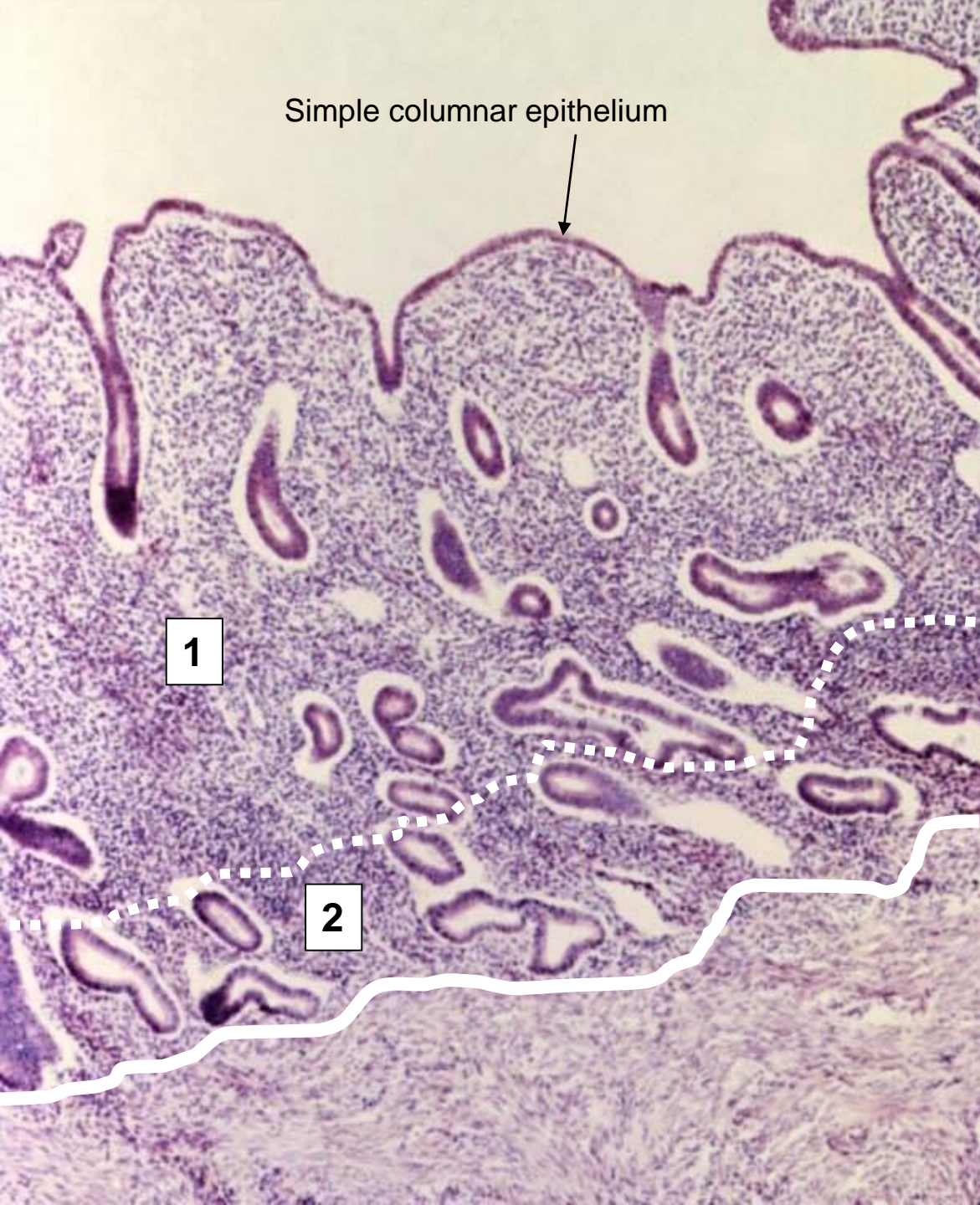


Hormonal regulation of ovarian and menstrual cycle

- **hypothalamus** (nucleus arcuatus):
gonadoliberin (GnRH)
 - **hypophysis**: **gonadotropiny**: FSH, LH
 - **ovarium**: **estrogens** (growing follicles, corpus luteum), **progesteron** (corpus luteum)
- uterus







Endometrium (proliferative phase):

- 1 – zona functionalis
- 2 – zona basalis



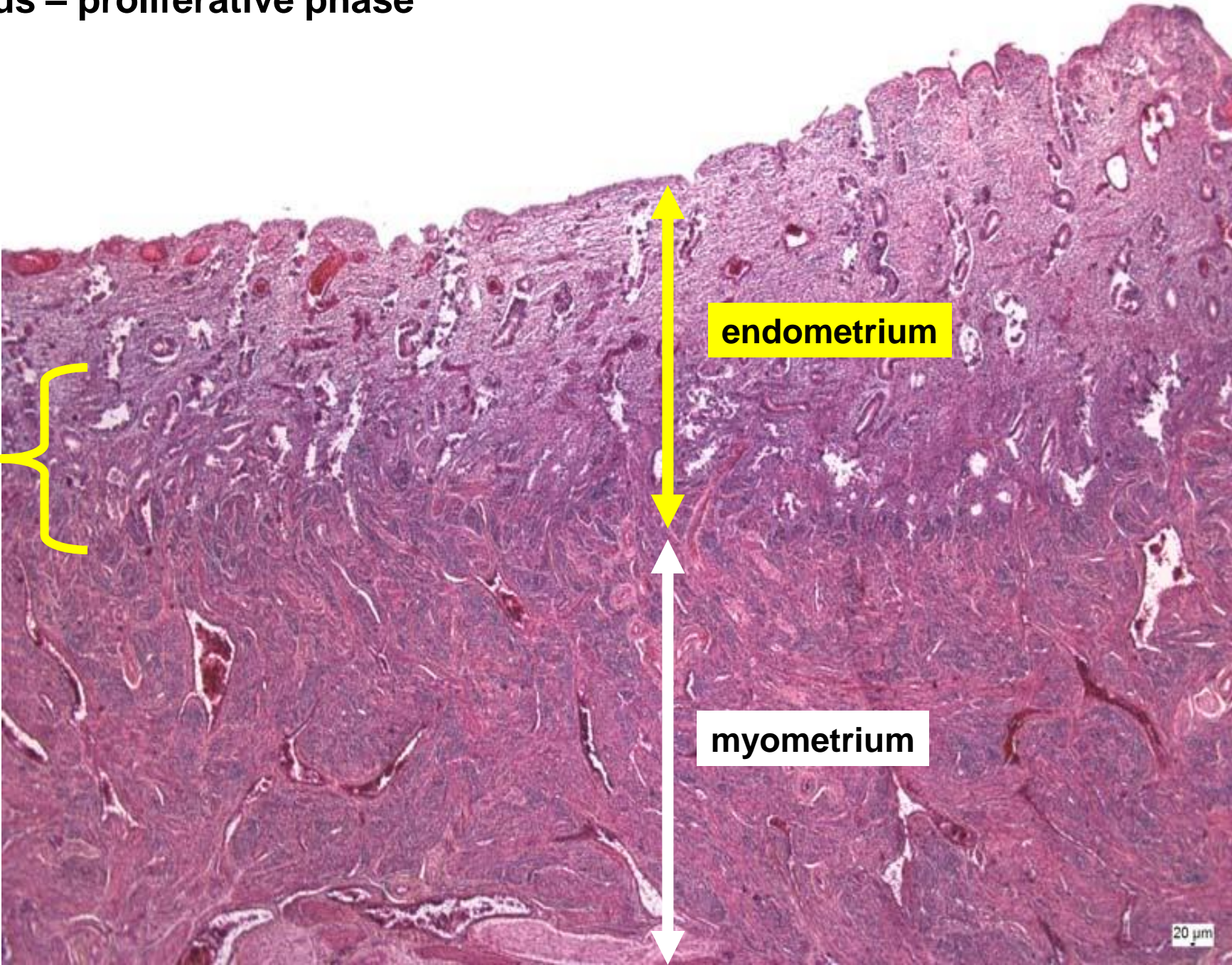
End of proliferative phase
14 days



Initial secretory phase
15–21 days

Late secretory phase
22–28 days

Uterus – proliferative phase



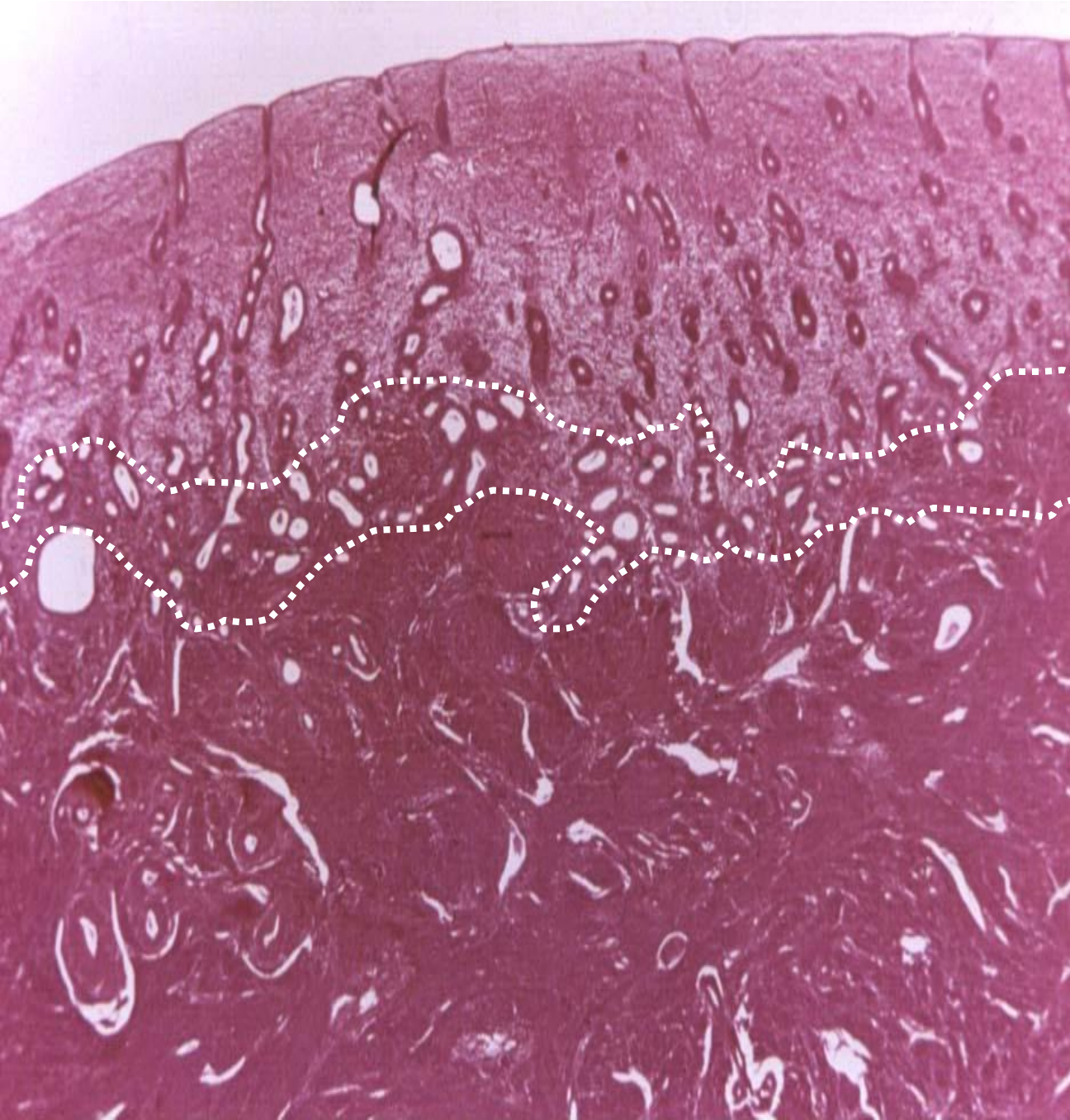
endometrium

myometrium

3-4 mm

20 μ m

Endometrium – proliferative phase



← epithelium

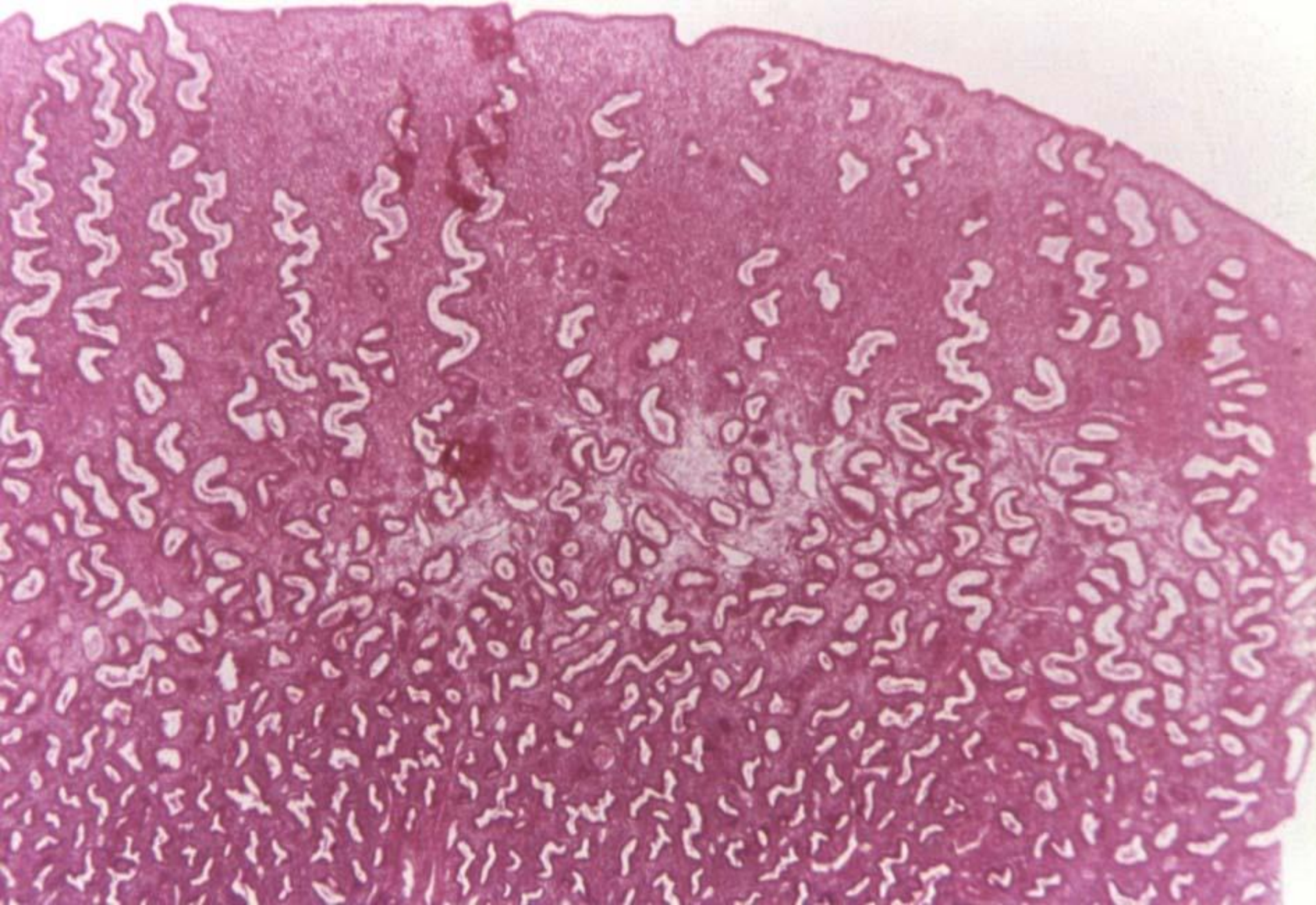
← zona functionalis

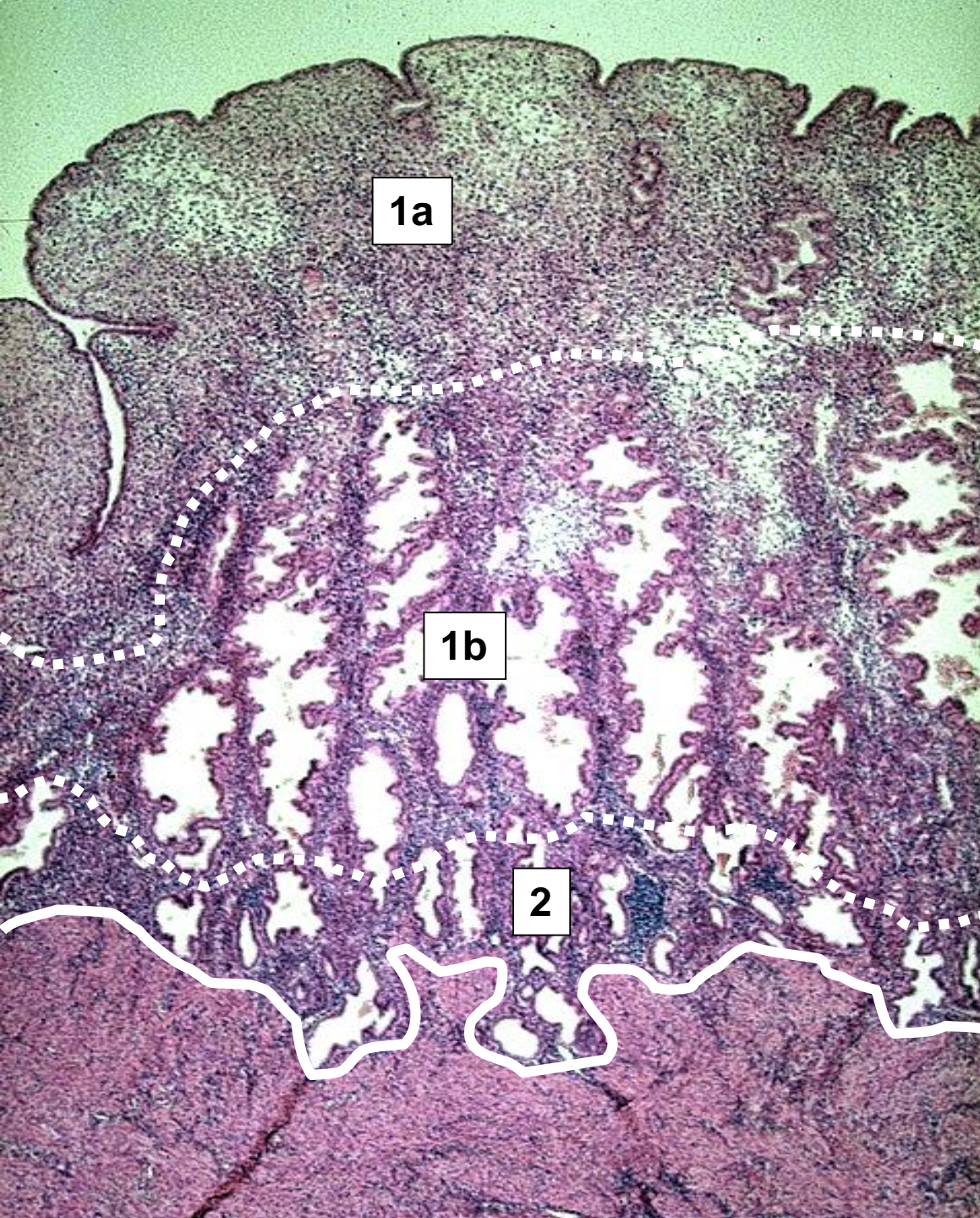
← zona basalis

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Endometrium – beginning of secretory phase





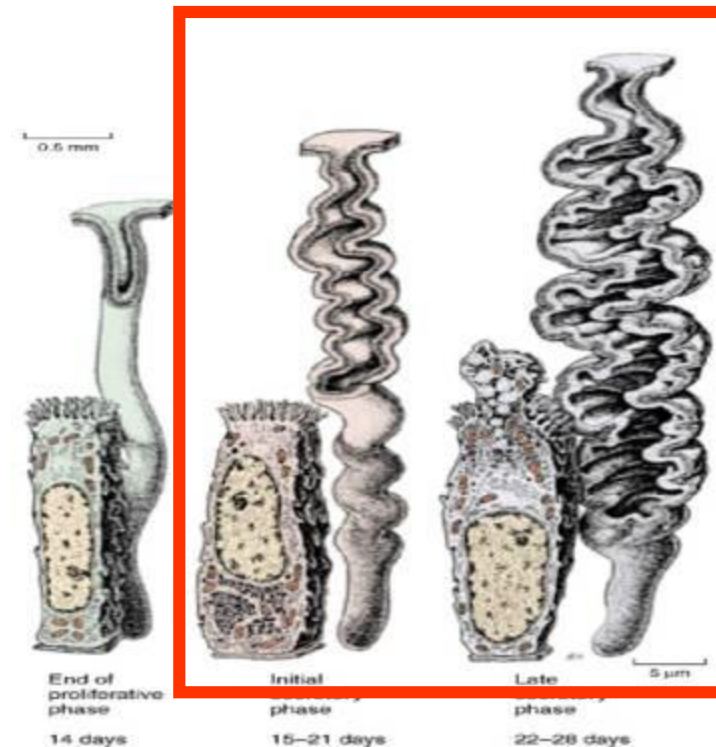
Endometrium (secretory phase):

1a – pars compacta

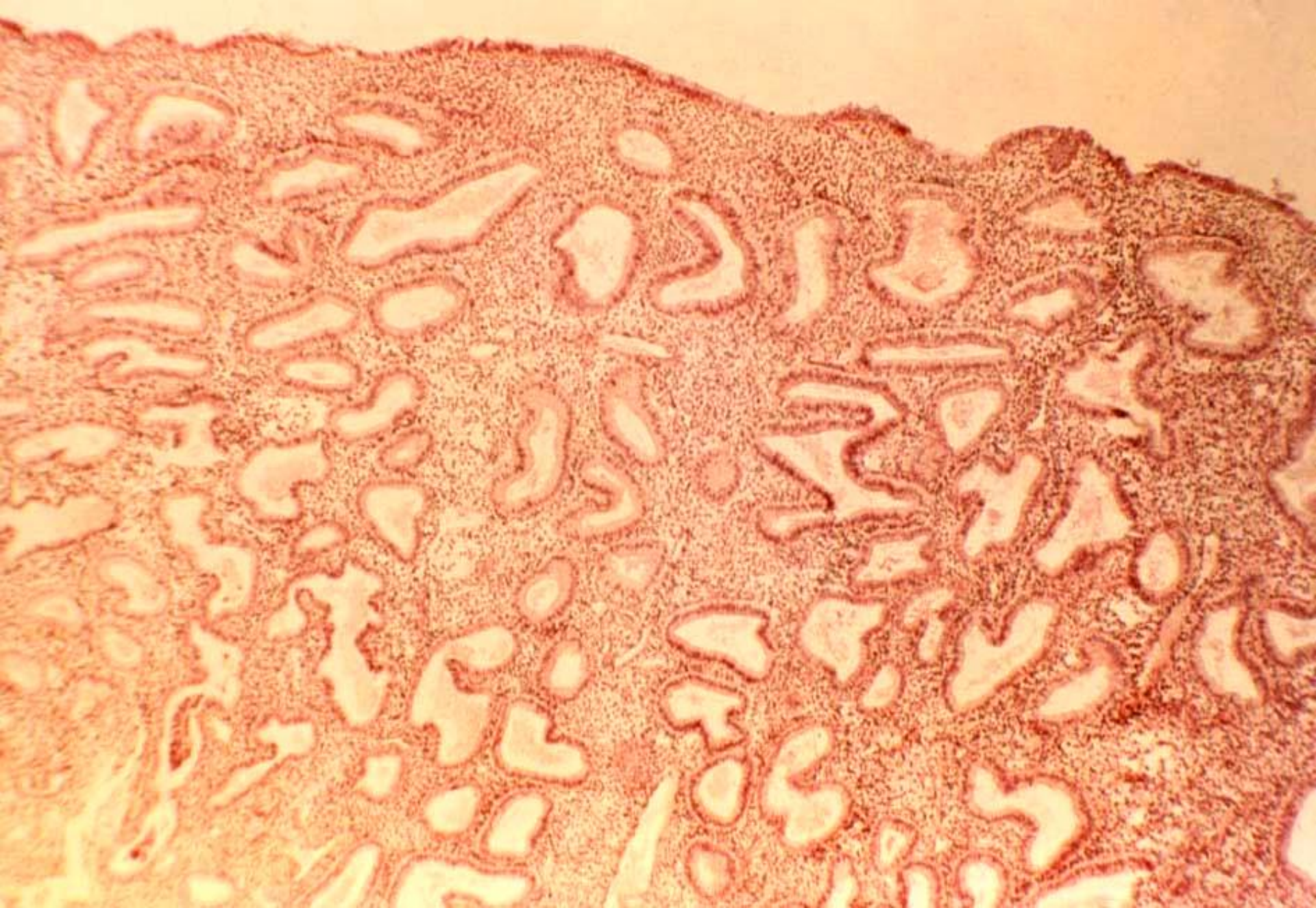
1b – pars spongiosa

zona functionalis

2 – zona basalis

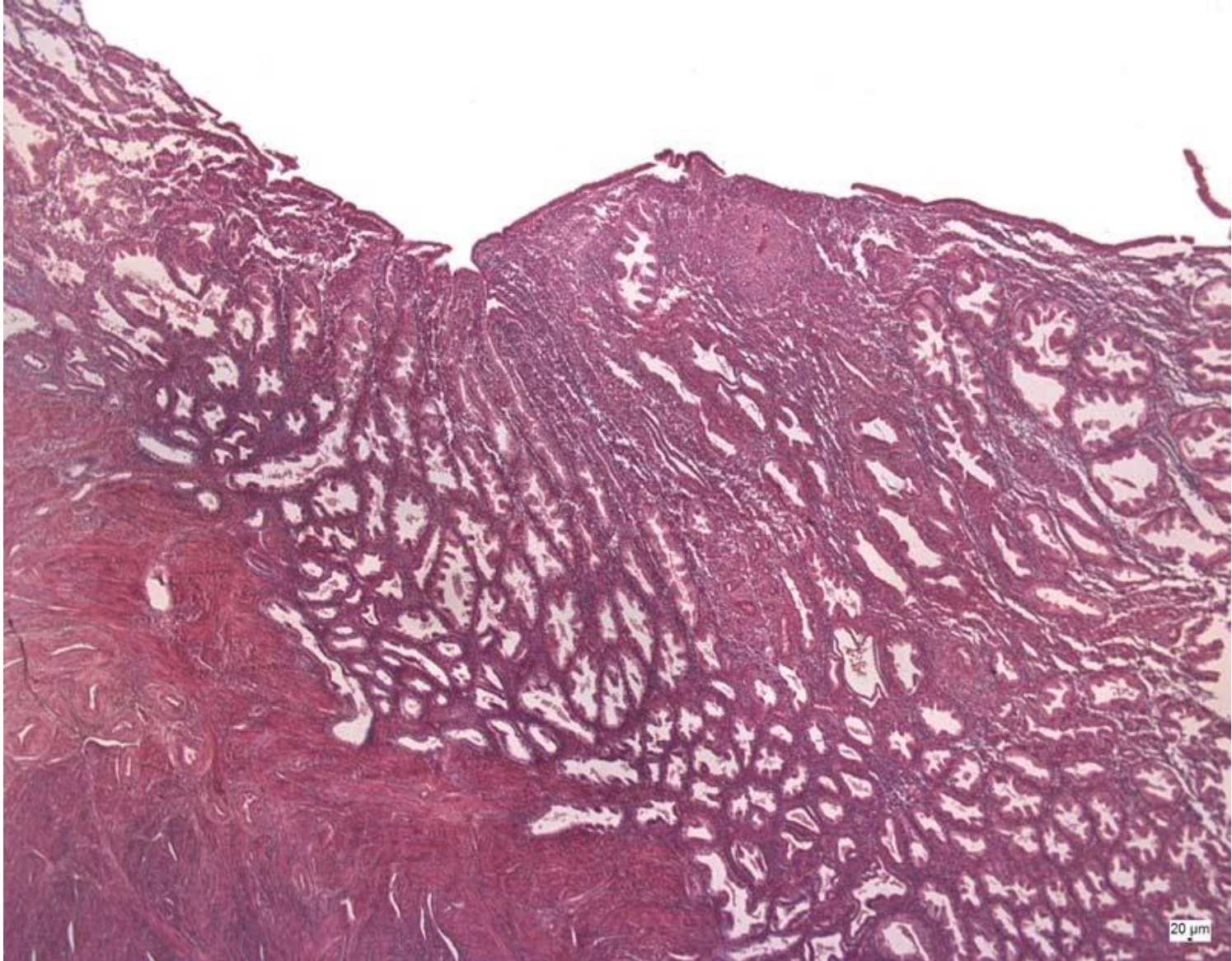


Endometrium – secretory phase

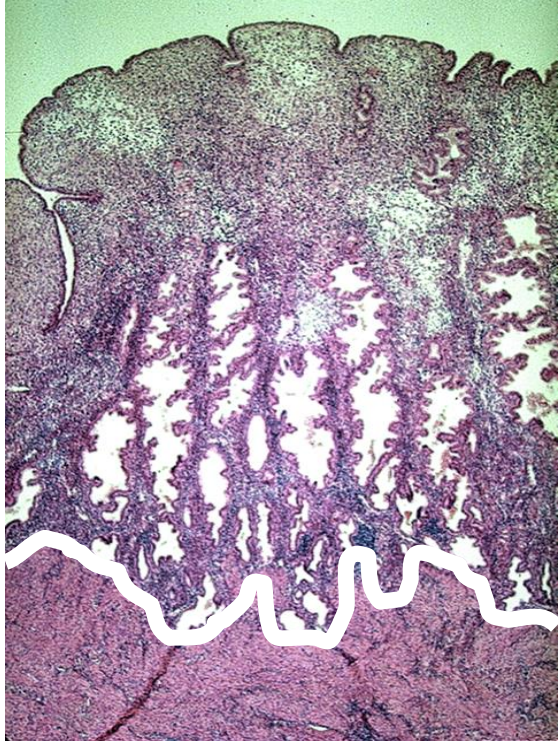
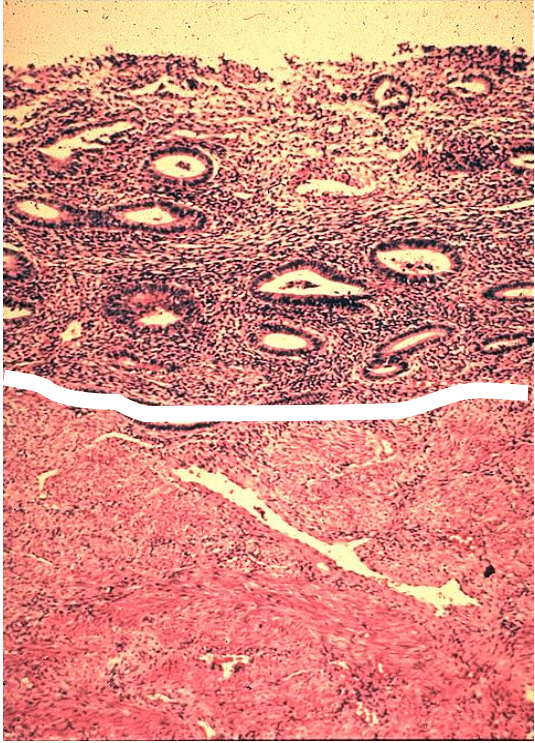


Uterus – secretory phase

5-7
mm



Endometrium during menstrual cycle:



(post)menstrual phase
zona basalis (1 mm)

proliferative phase
+ *zona functionalis* (5 mm)

secretory phase
(6 – 7 mm)
pars compacta
pars spongiosa



Cervix uteri



vagina

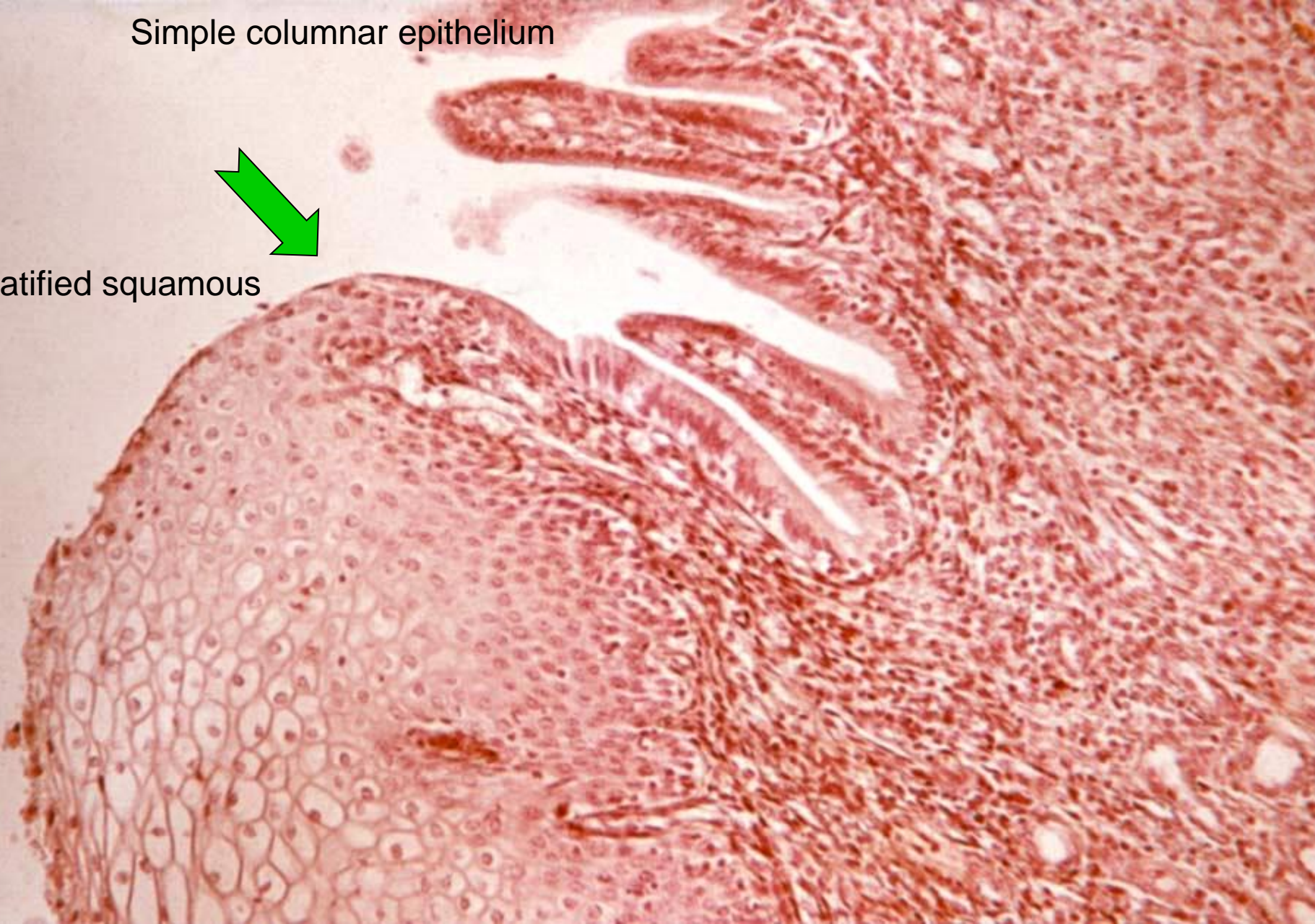
porcio vaginalis
cervicis uteri

Portio vaginalis cervicis uteri

Simple columnar epithelium

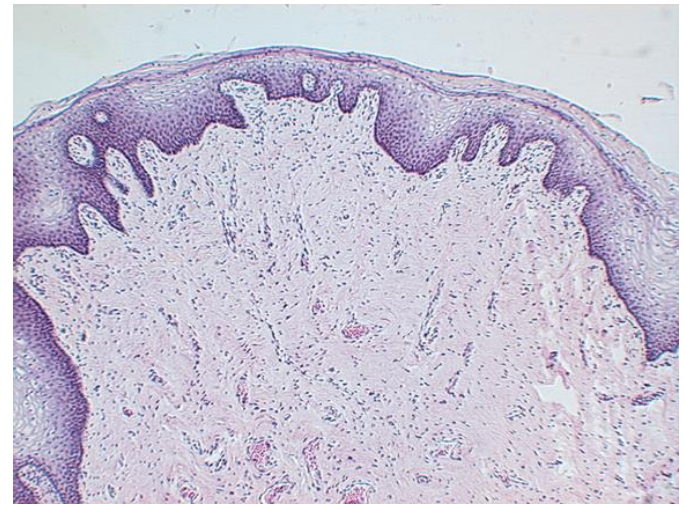


Stratified squamous



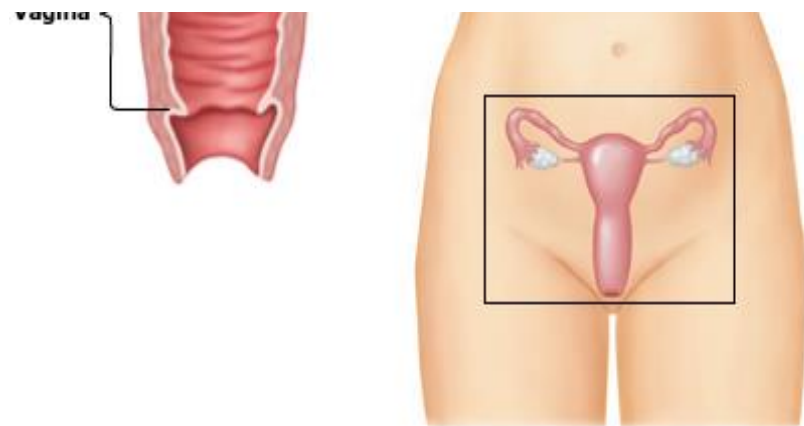
Vagina

Tunica mucosa:
epithelium (stratified squamous),
lamina propria)



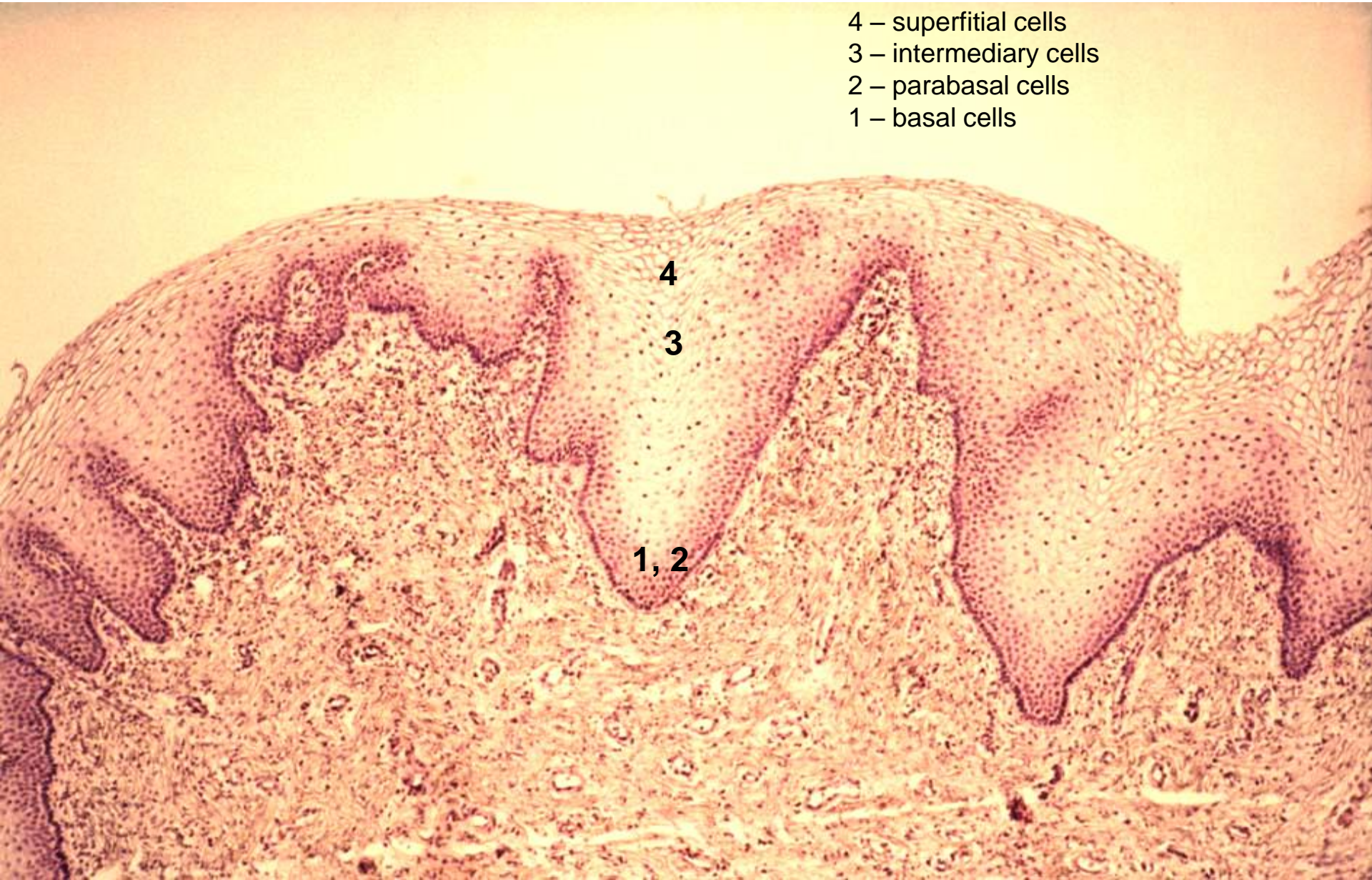
Tunica muscularis ext.
Spirally oriented smooth muscle tissue

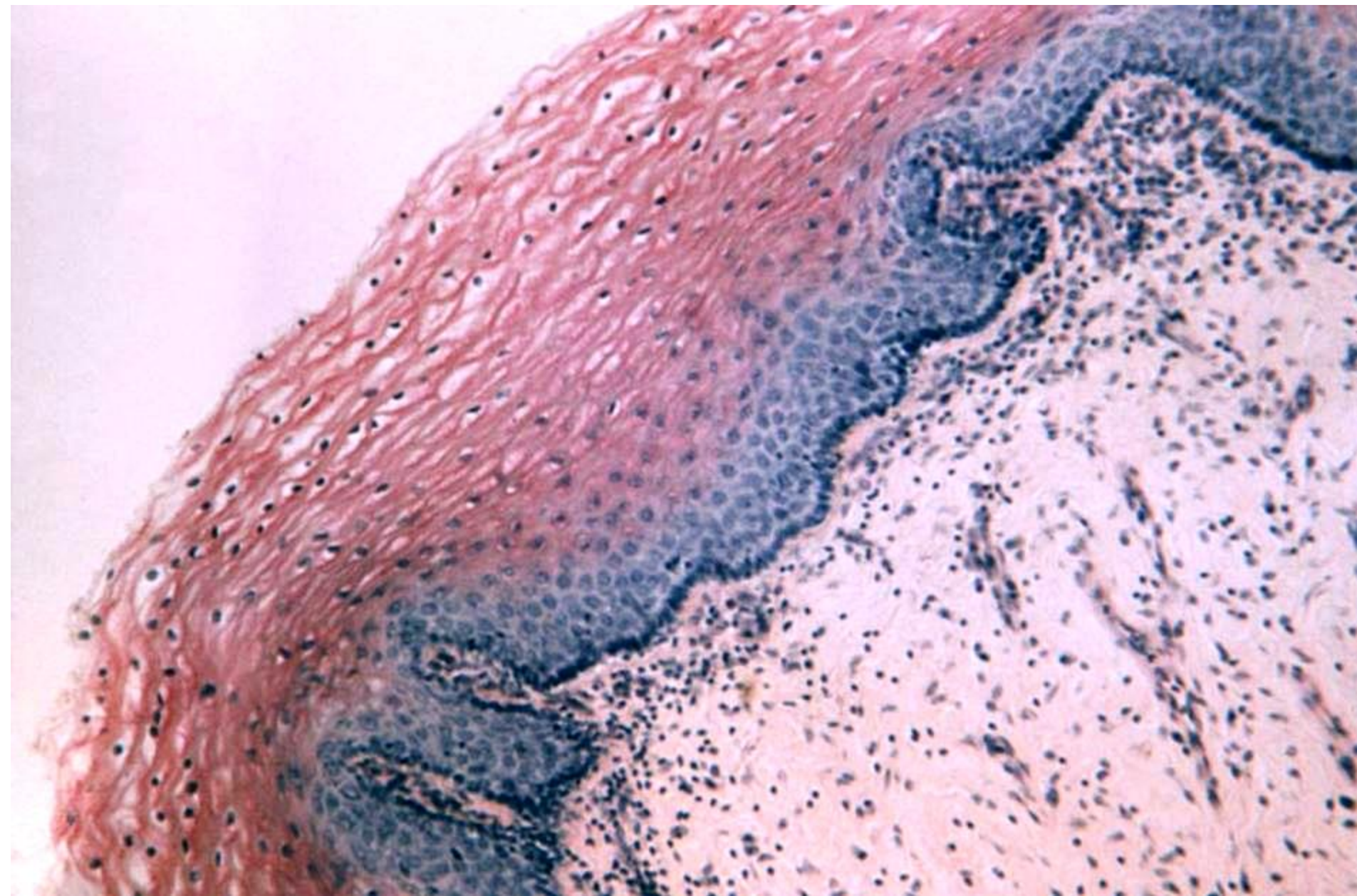
Tunica adventitia



Vagina - mucosa (HE)

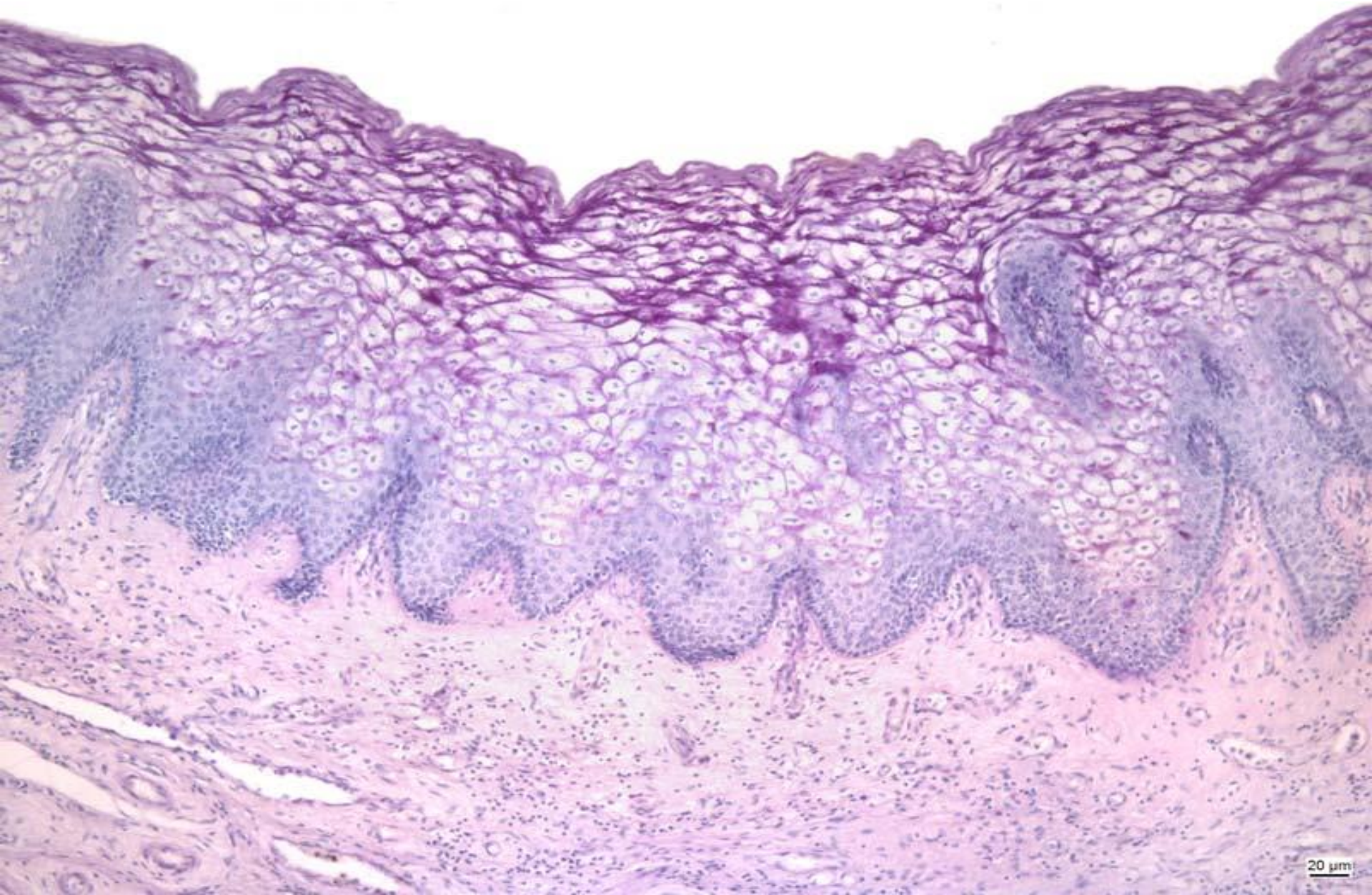
- 4 – superficial cells
- 3 – intermediary cells
- 2 – parabasal cells
- 1 – basal cells



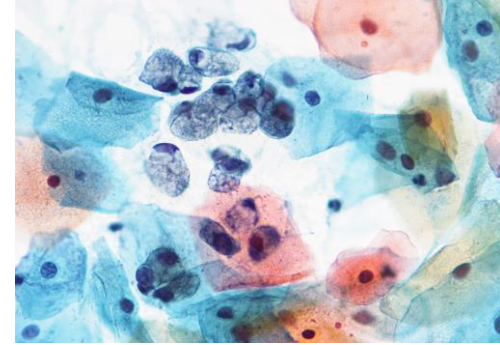


Vagina – Best's carmine (glycogen)

glycogen + lactobacillus acidophilus (Döderline) → lactic acid /pH 3.8-4/

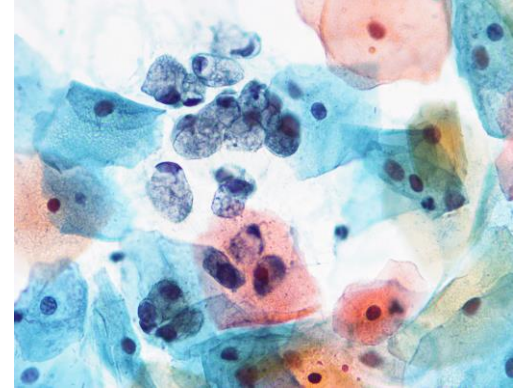


Vaginal cytology



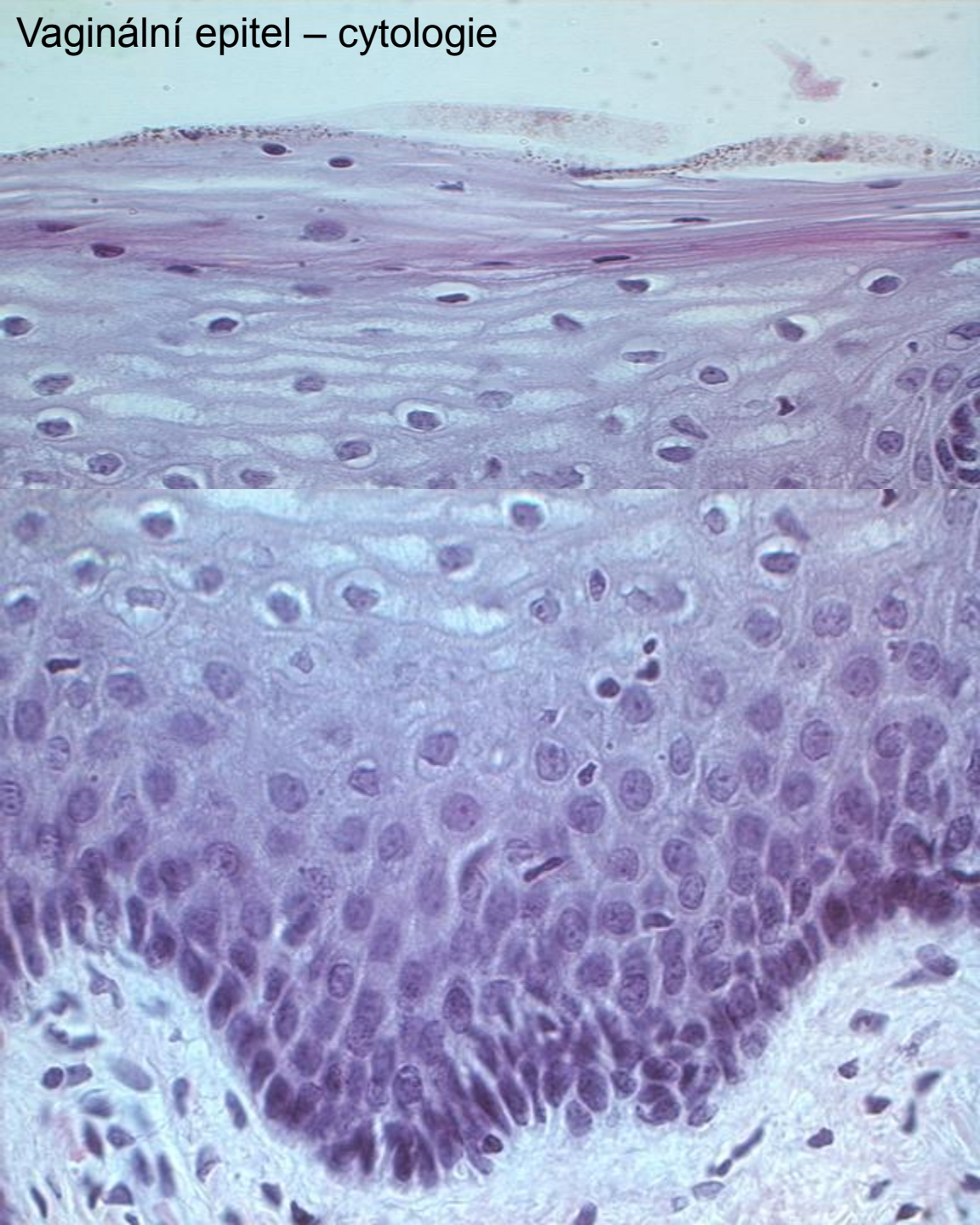
- The vaginal epithelium is **responsive to sex steroids** (estrogen), and undergoes changes through the cycle in response to changes in blood estrogen concentrations. Rising levels of estrogen cause the vaginal epithelium to become "*cornified*" - the surface cells become large and flattened, with small or absent nuclei.
- Vaginal cytology is a type of **endocrine assay**. Tracking changes in the morphology of desquamated vaginal epithelial cells provides a convenient means of changes in estrogen levels.

Vaginal cytology

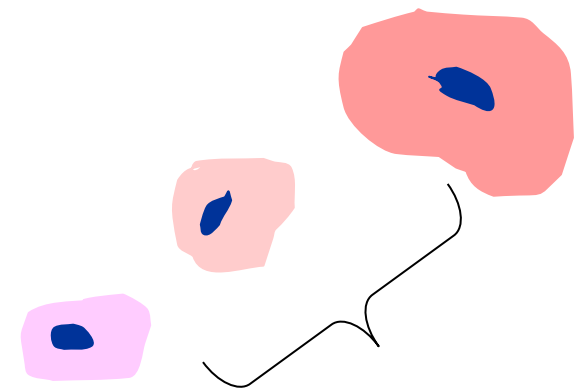
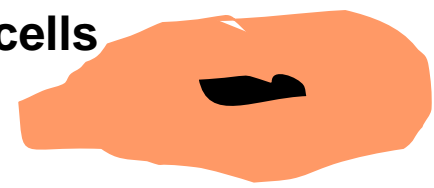


- **functional** (hormonal) – cell appearance is classified (menstrual cycle or pathophysiological gravidity can be monitored)
- **onkological** – cells received from endocervix and stained according to Papanicolau (pap smears signed as **PAP I – V**, now known as **Bethesda** system) are studied.

Vaginální epitel – cytologie



Superficial cells



Intermediate cells



Parabasal cells

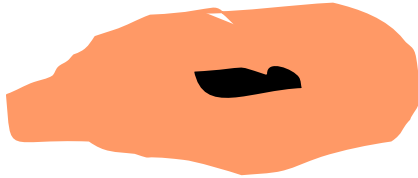


Basal cells

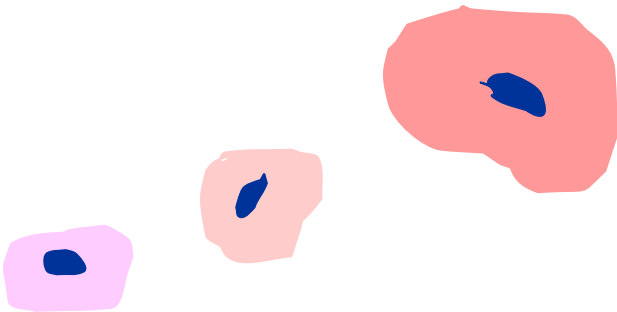
Classification of vaginal epithelial cells

(cell size, staining of cytoplasm, nucleo-cytoplasmic ratio)

Superficial cells – during proliferative phase
(estrogen influence)



Intermediate cells – during secretory phase
(progesterone influence)
+ *leukocytes in smear*



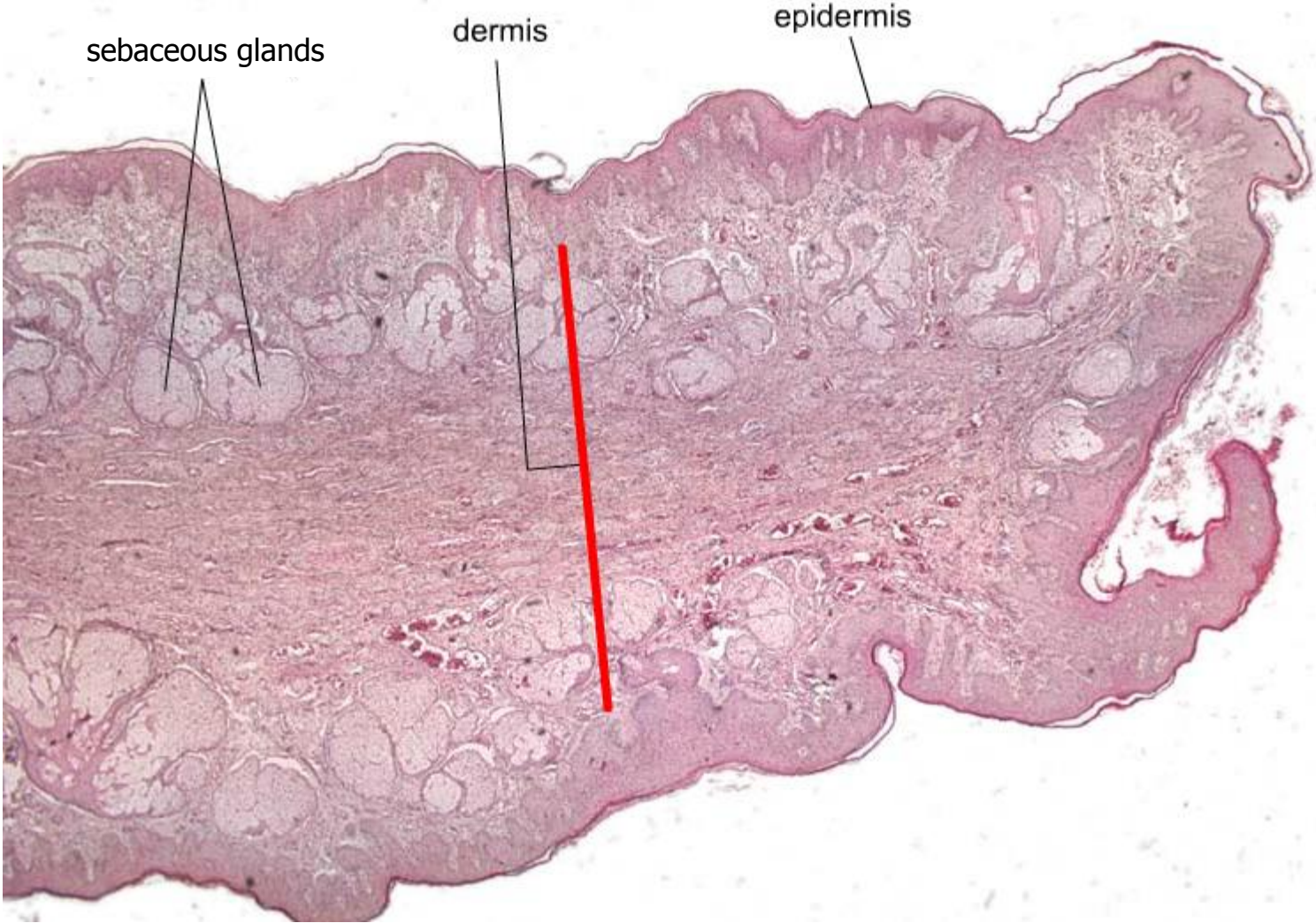
Parabasal cells – during childhood or senium
(epithelial atrophy)



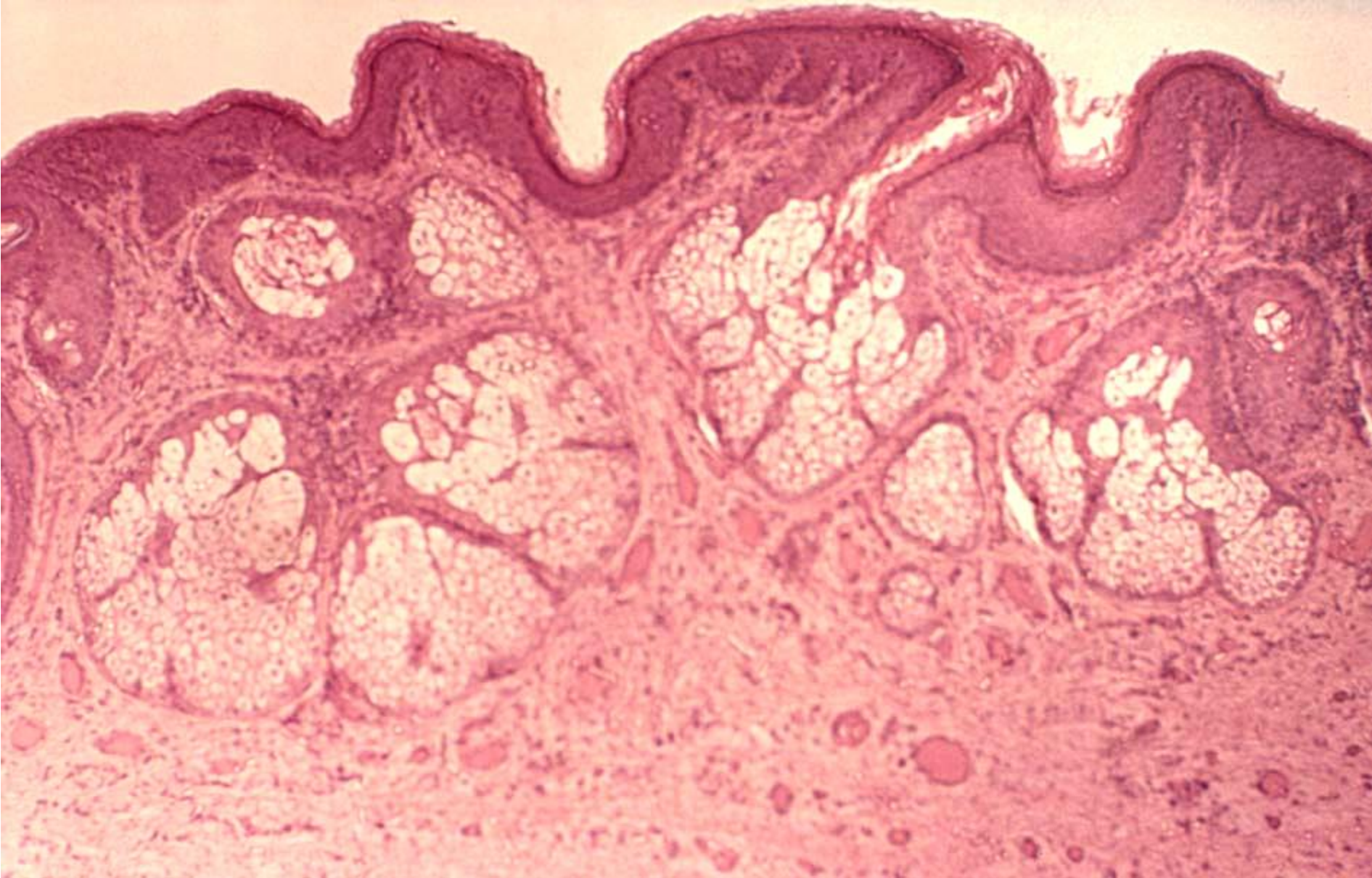
Basal cells – normally not present in smears
(indicate a deep damage of the epithelium)



Labium minus



Labium minus



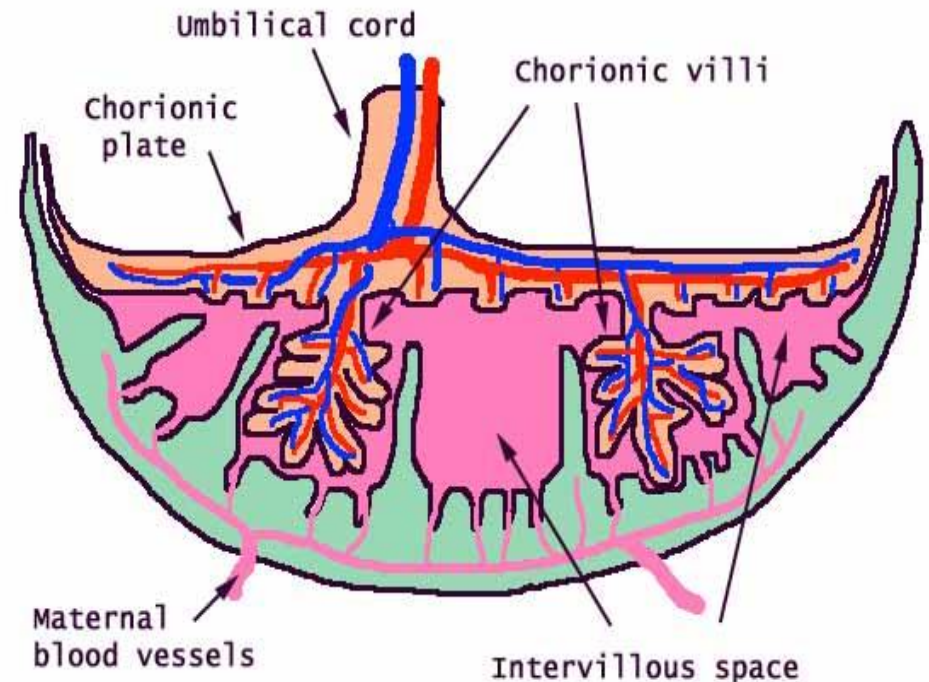
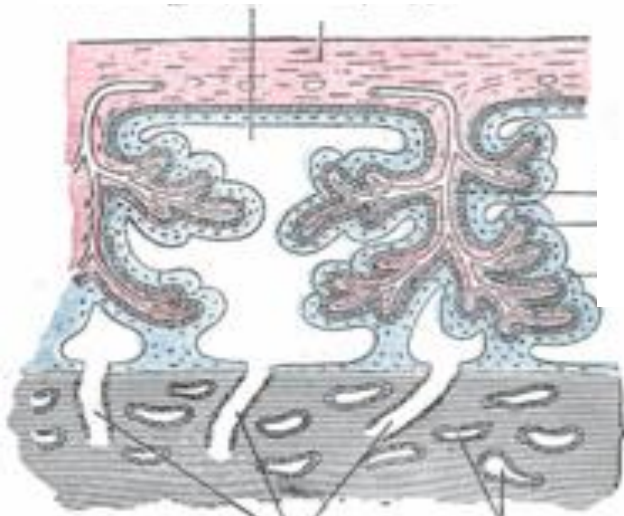
Human placenta

- **discoidalis**
- **olliformis**
- **hemochorialis**



Human placenta

- pars fetalis – chorionic plate, chorionic villi (anchoring, free)
- pars materna – decidua basalis
- intervillous space



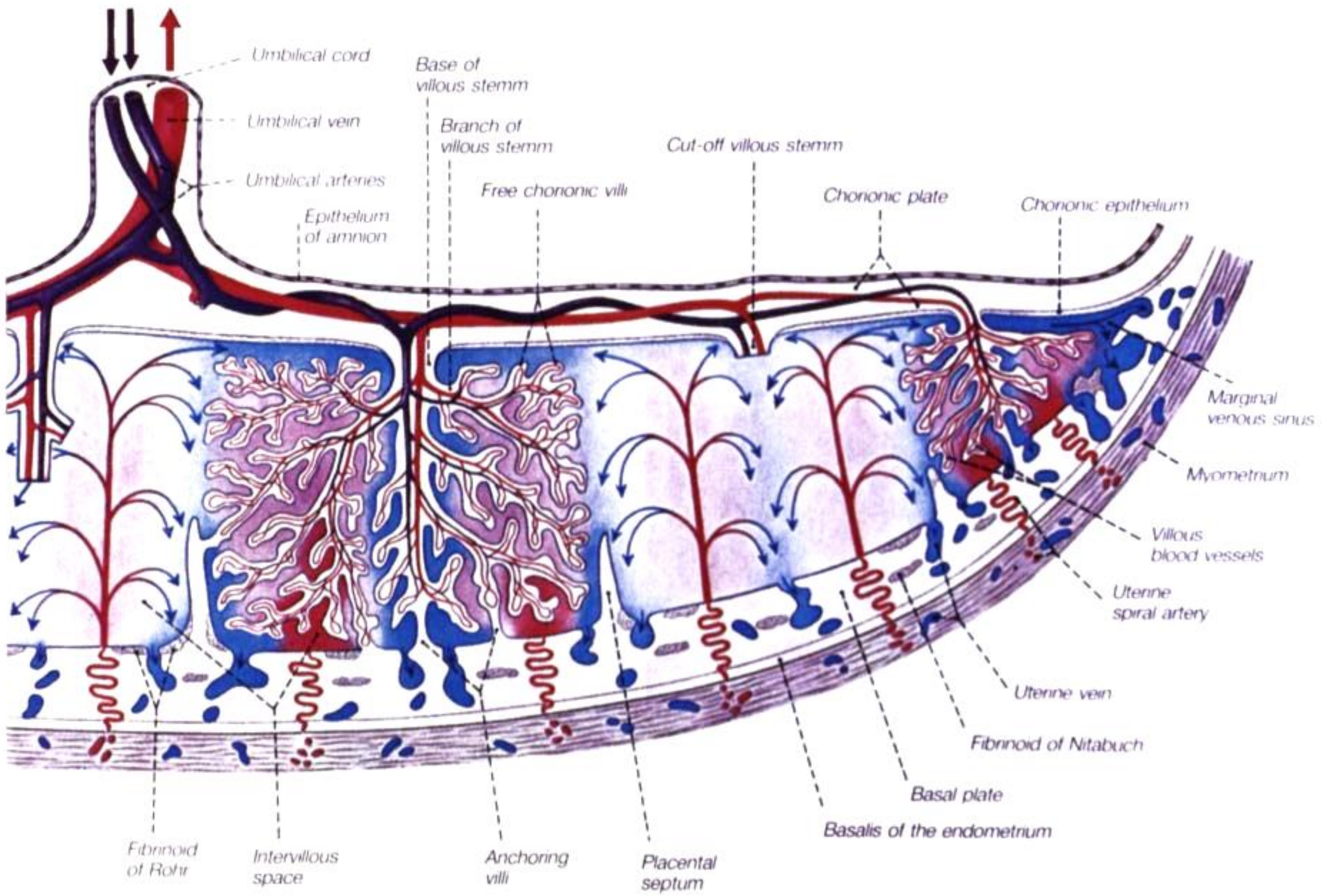
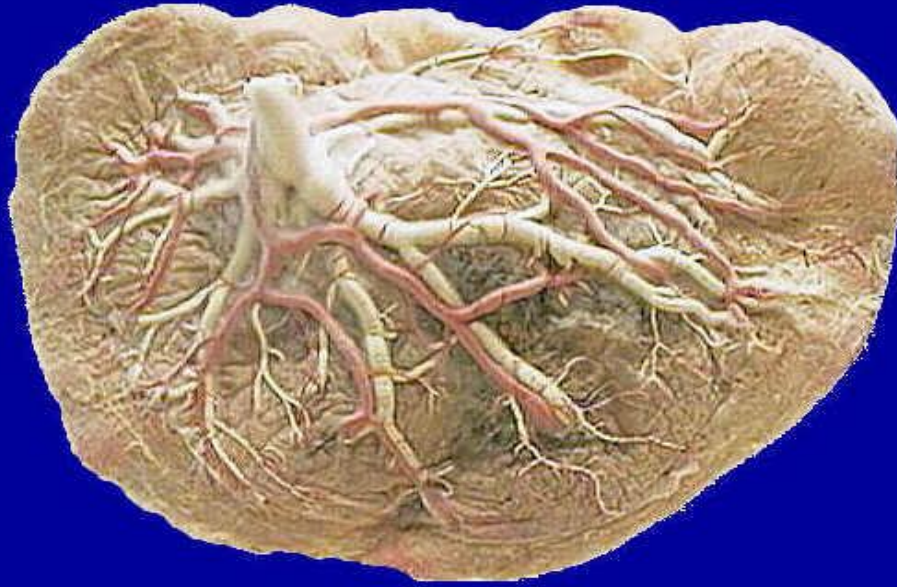
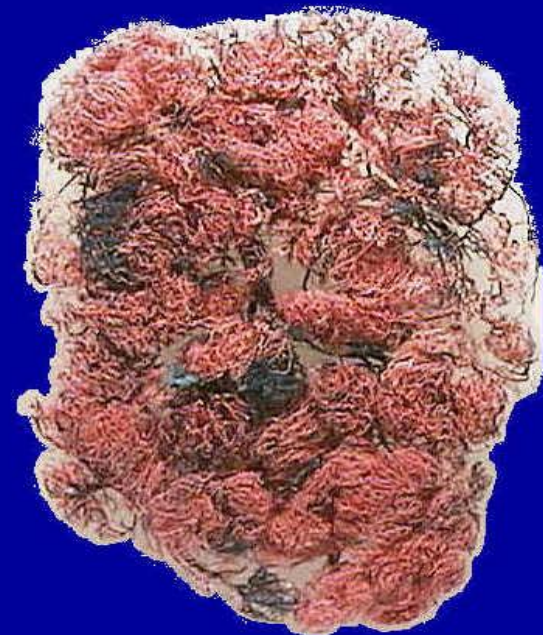


Fig8 Human Placenta - Foetal Aspect

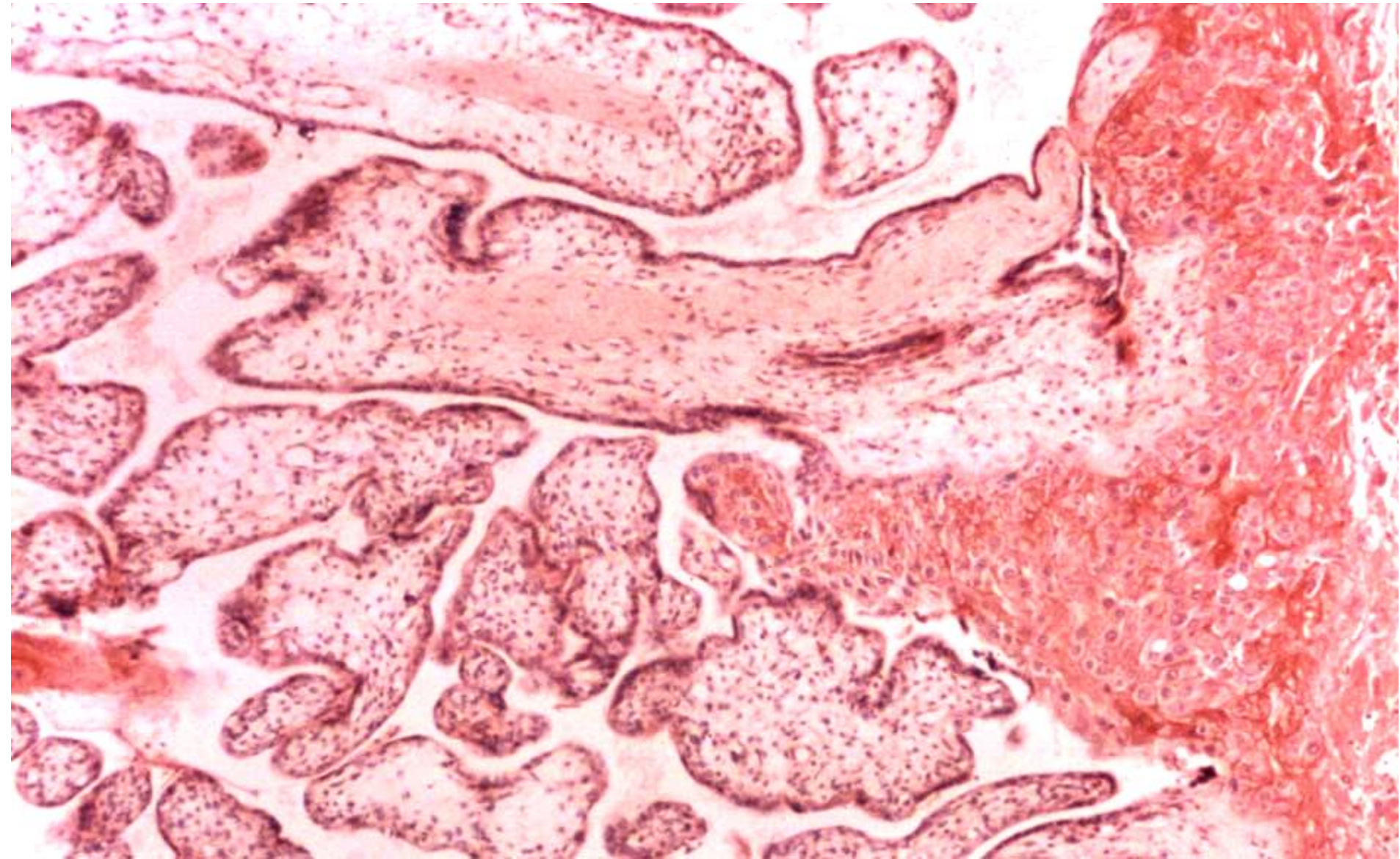


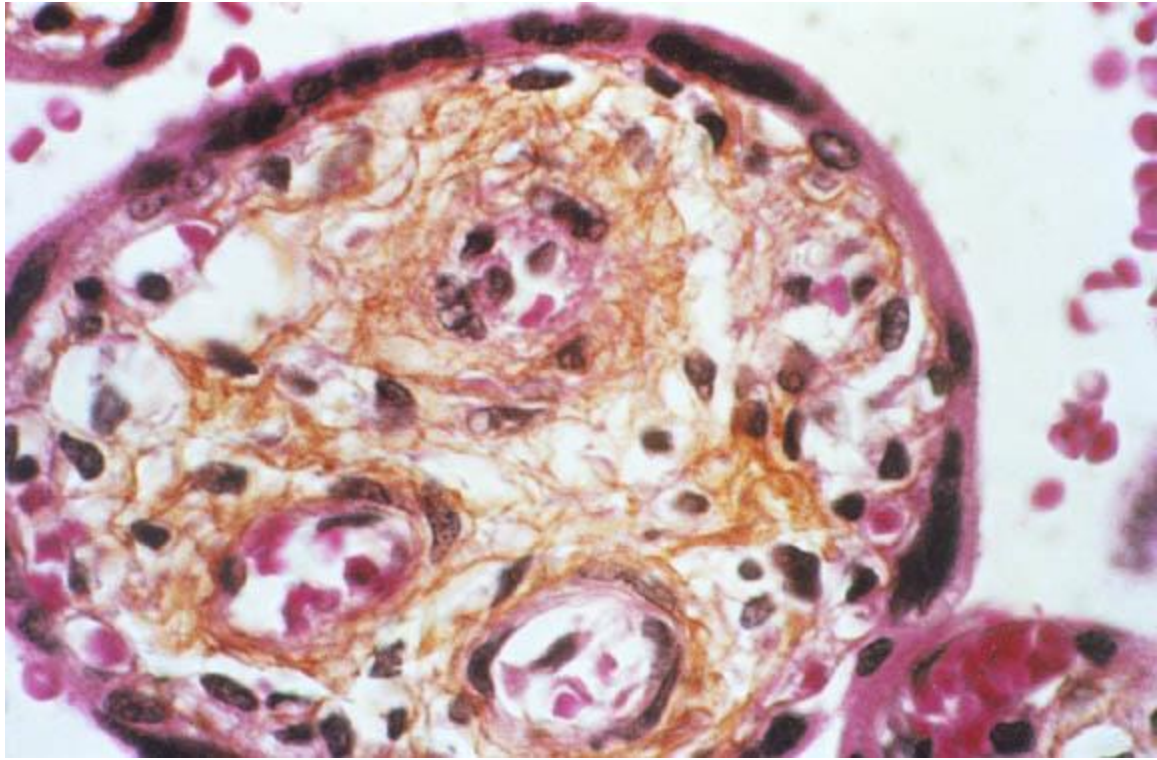
Showing the umbilical vessels Red = Umbilical artery
White = Umbilical Vein

Fig3 Cast of Umbilical Vessels of Human Placenta



Maternal Aspect. The placenta was oval in shape.
Red = Artery Blue = Vein



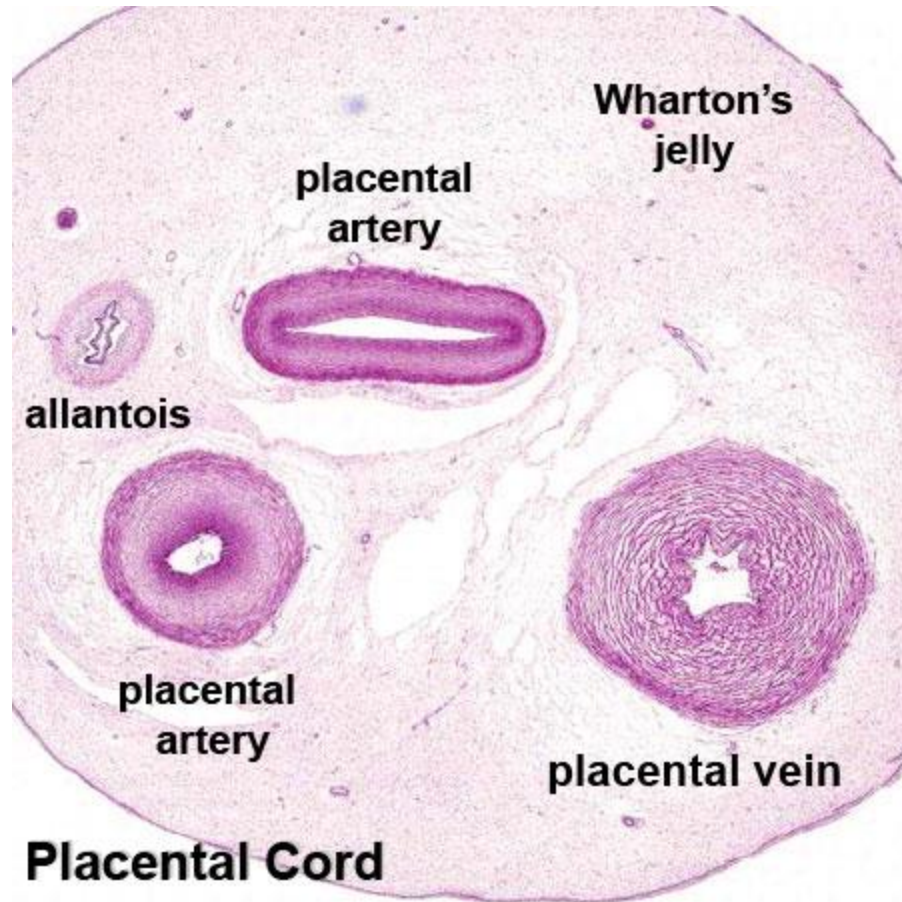


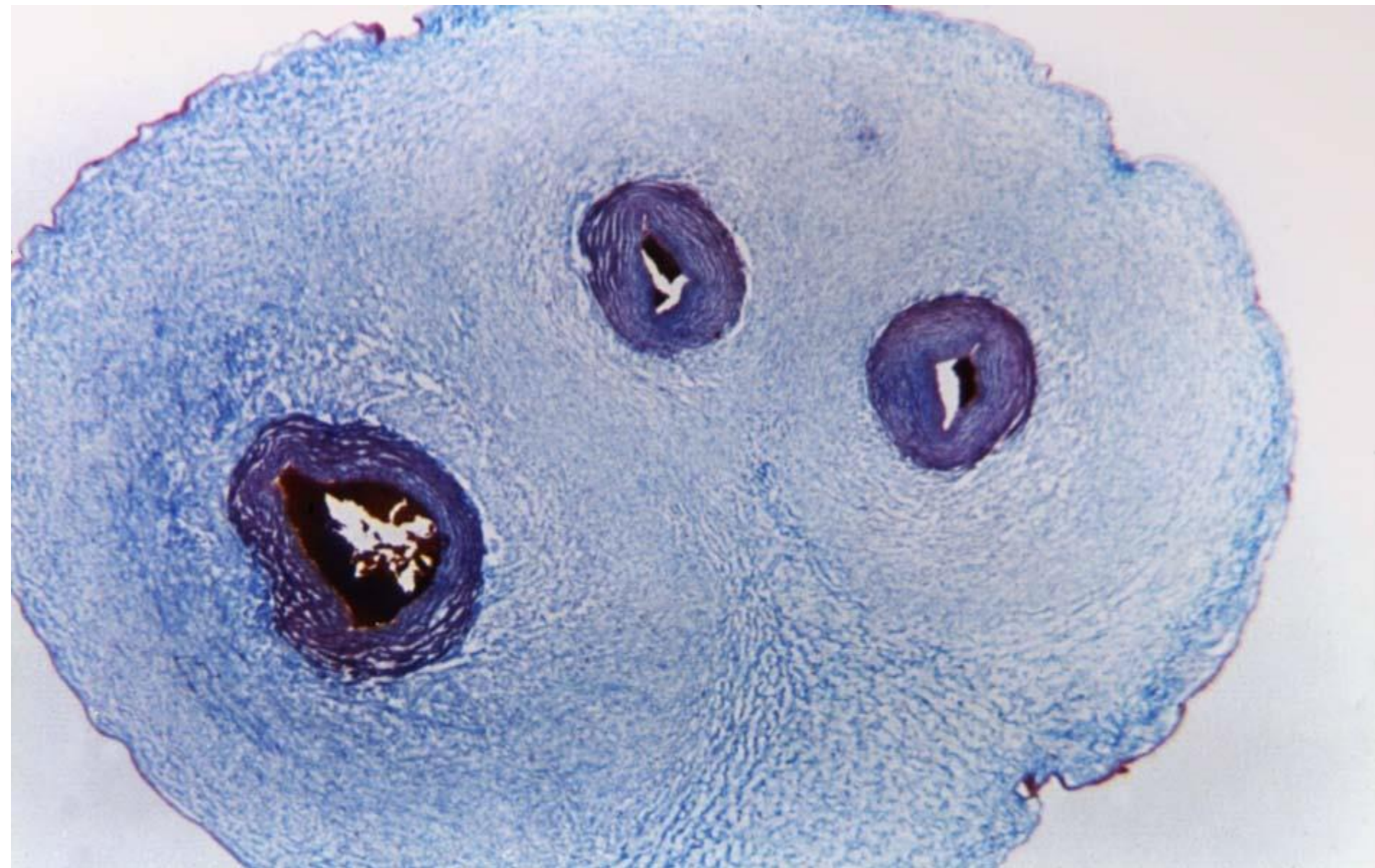
Placental barrier:

- **Midgestation:** endothelium of capillaries + basal membrane, CT, cytotrofoblast, basal membrane of syncytiotrofoblast, syncytiotrofoblast
- **5th month to birth:** endothelium of capillaries + basal membrane, basal membrane of syncytiotrofoblast, syncytiotrofoblast

Functions

- transport (O₂, CO₂, ions, water, nutrition, hormones, antibodies, metabolites, chemical substances, drugs, infection agents)
- endocrine (hCG, somatomamotropin, tyrotropin, kortikotropin; progesteron, estrogens)
- metabolic (glycogen, cholesterol, fatty acids)





7.

Female reproductive system – II



Slides:

- 47. Uterus – proliferative phase (HE)
- 48. Uterus – secretory phase (HE)
- 49. Vagina (Best's carmine) – glycogen
- 50. Vagina (HE)
- 51. Labium minus (HE)
- 99. Funiculus umbilicalis (HE or Azan)
- 100. Placenta (HE)