

Functional anatomy:

Female Genital System



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The organs:

Ovaries

Fallopian tubes

Uterus (corpus + cervix)

Lower genital tract (vagina and vulva)

Placenta

The functions:

Conception

Delivery of the baby

Synthesis of estrogen and progesterone (hormonal organ)

How to:

Ovaries provide the oocyte(s) and ovulate

Fertilization in the **fallopian tubes** and transportation to uterine cavity

Implantation and placental formation in the **uterus**

Ovaries and **placenta** function as hormonal organs to maintain the pregnancy

Induction of labor and delivery through **vagina**

Review of anatomy

Figure 6: Ovary

- 1 Ovarian ligament
- 2 Corpus luteum
- 3 Ovum
- 4 Mature (Graafian) follicle
- 5 Corpus albicans
- 6 Primary follicles
- 7 Cortex
- 8 Medulla

Figure 7: Uterus, Vagina & Ovaries

- 1 Ampulla of Uterine tube
- 2 Suspensory ligament of ovary
- 3 Infundibulum of Uterine tube
- 4 Fimbria of Uterine tube
- 5 Ovary
- 6 Ovarian ligament
- 7 Body of uterus
- 8 Isthmus of uterus
- 9 Cervix
- 10 Vaginal wall
- 11 Round ligament
- 12 Isthmus of Uterine tube
- 13 Fundus of uterus
- 14 Cavity of uterus
- 15 Myometrium
- 16 Endometrium
- 17 Cervical canal
- 18 Fornix of vagina
- 19 Vagina
- 20 Hymen
- 21 Labium minus
- 22 Vestibule of vagina

Figure 8: Female Pelvic Area

- 1 Round ligament
- 2 Uterus
- 3 Ovary
- 4 Uterine tube
- 5 Uterosacral ligaments
- 6 Symphysis pubis
- 7 Urinary bladder
- 8 Internal urethral orifice
- 9 Clitoris
- 10 Urogenital diaphragm
- 11 Urethra
- 12 Labium minus
- 13 Labium majus
- 14 Vaginal opening
- 15 Anus
- 16 Vagina
- 17 Anterior vaginal fornix
- 18 Cervix
- 19 Posterior vaginal fornix
- 20 Rectum

Figure 9: Full Term Pregnancy

- 1 Placenta
- 2 Umbilical cord
- 3 Fetus
- 4 Amnion

Figure 10: Muscles of Female Perineum

- 1 Ischiopubic ramus
- 2 Bulboispongiosus muscle
- 3 Ischiocavernosus muscle
- 4 Inferior fascia of urogenital diaphragm
- 5 Superficial transverse perineal muscle
- 6 Levator ani muscle
- 7 External anal sphincter
- 8 Gracilis muscle
- 9 Urethral orifice
- 10 Labium minus
- 11 Adductor magnus muscle
- 12 Vaginal orifice
- 13 Gluteus maximus muscle
- 14 Anus

Figure 6: Ovary (Coronal Section)

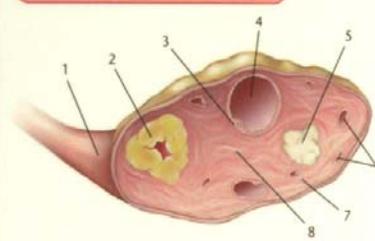


Figure 8: Female Pelvic Area (Median Sagittal Section)

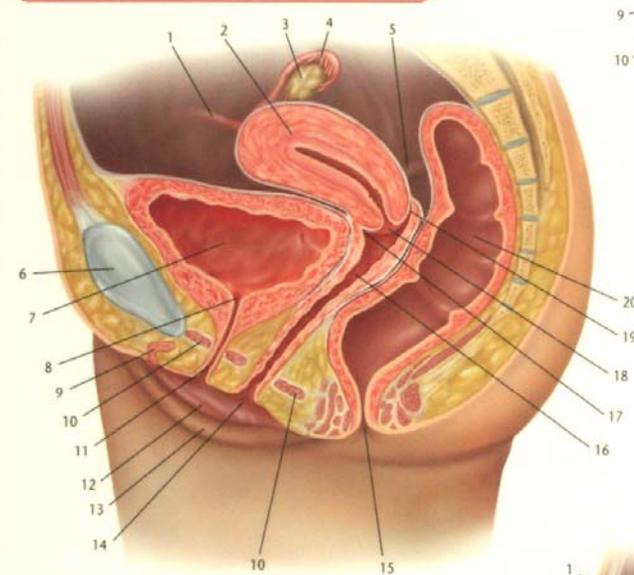


Figure 10: Muscles of Female Perineum (Inferior View)

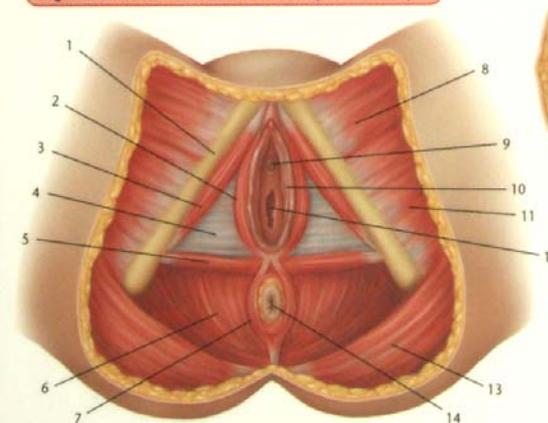


Figure 7: Uterus, Vagina & Ovaries (Anterior View)

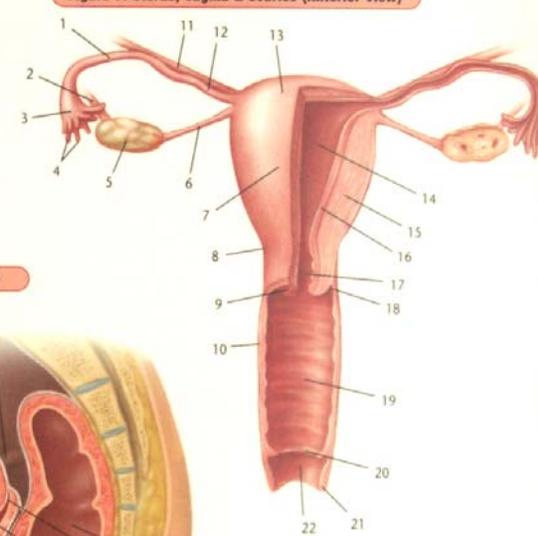
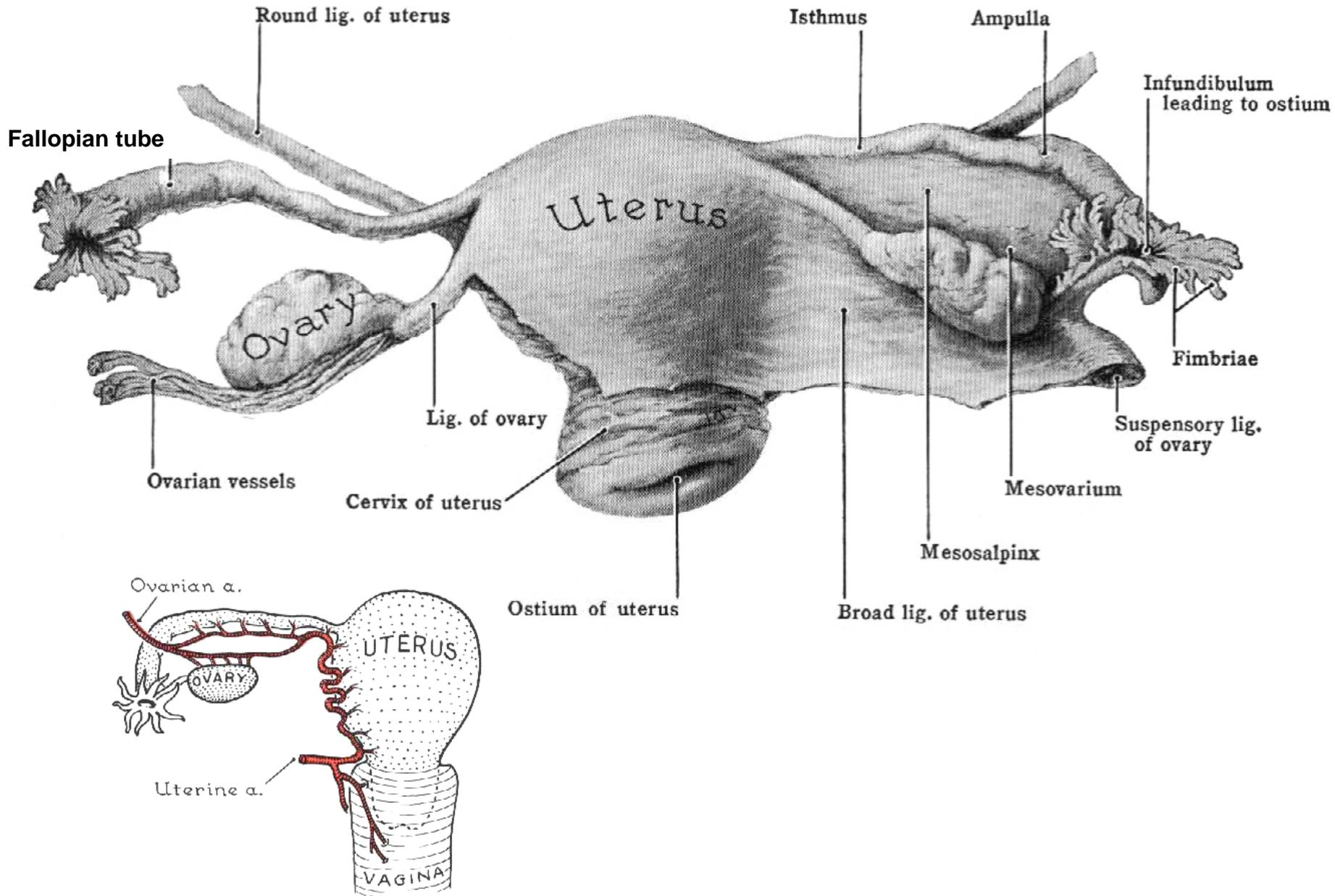


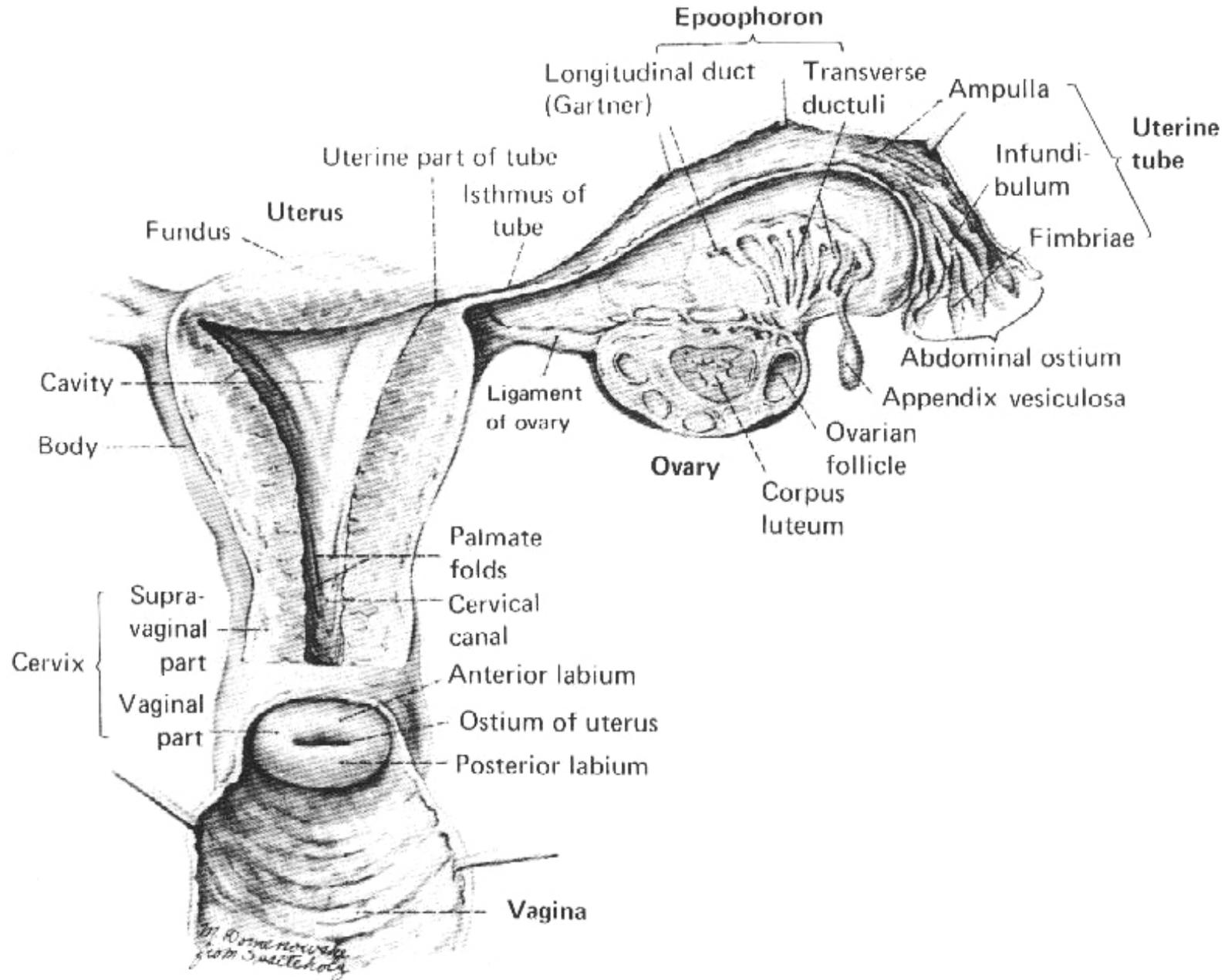
Figure 9: Full Term Pregnancy (Median Sagittal Section)



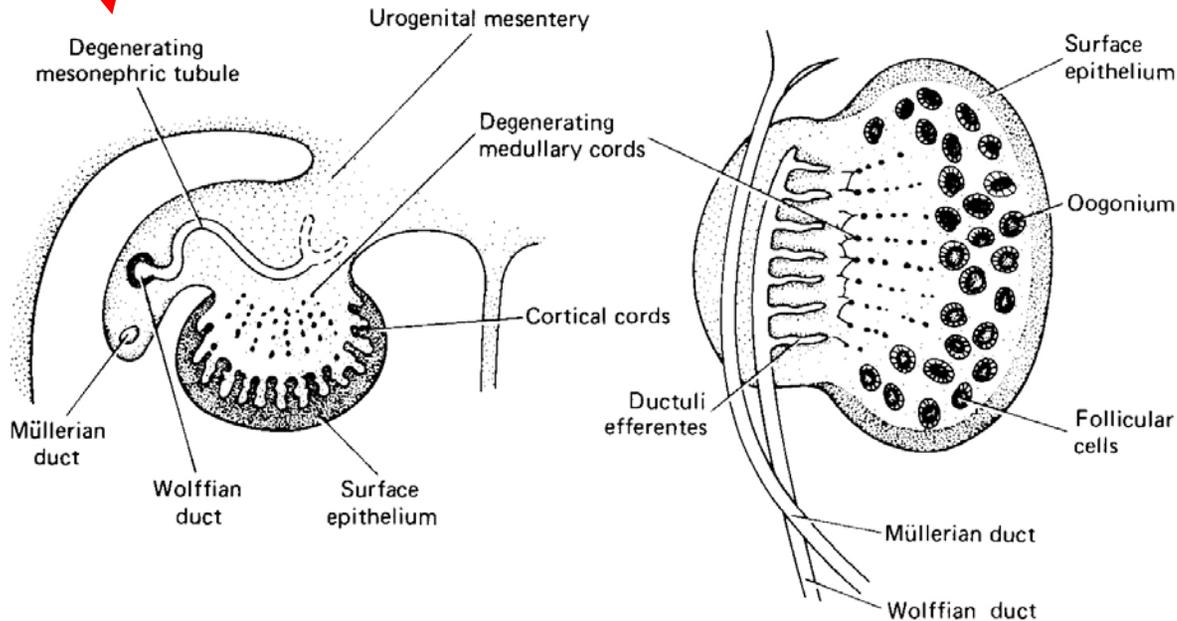
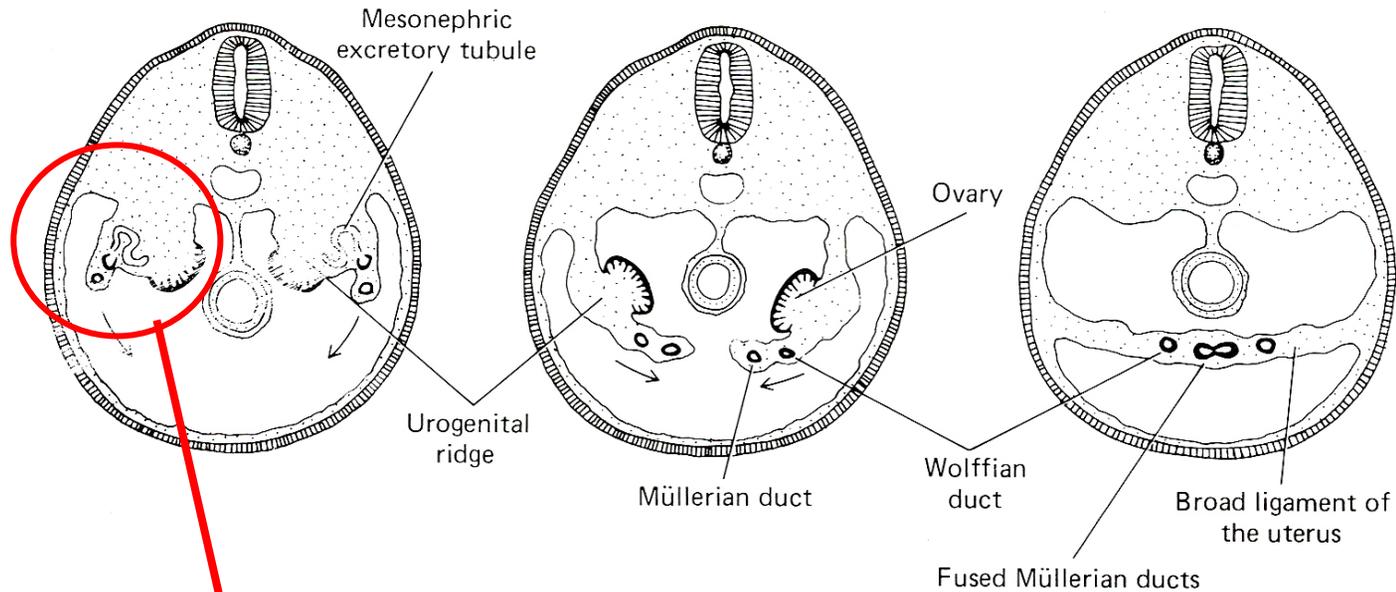
Gross anatomy of female genital organs-1



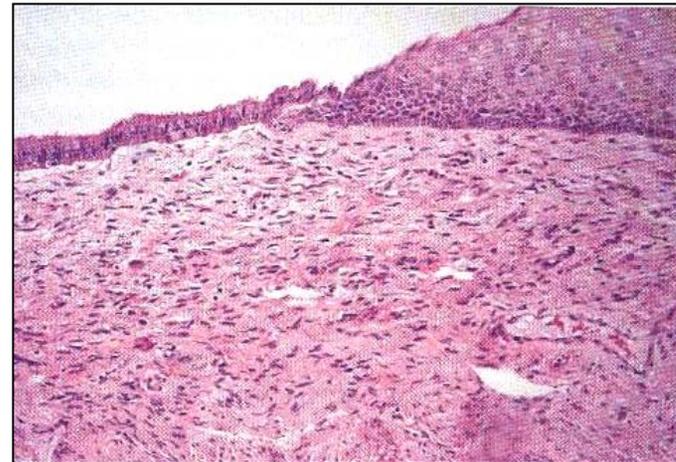
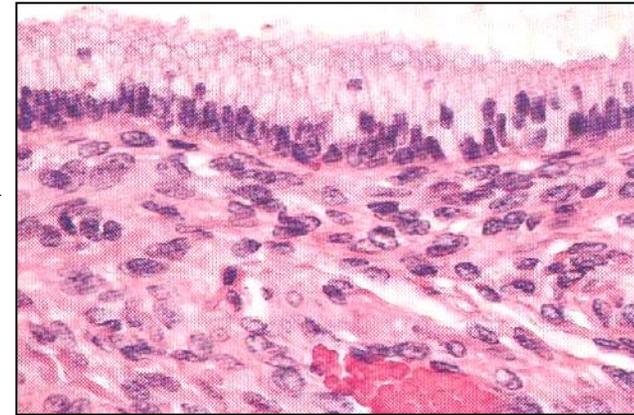
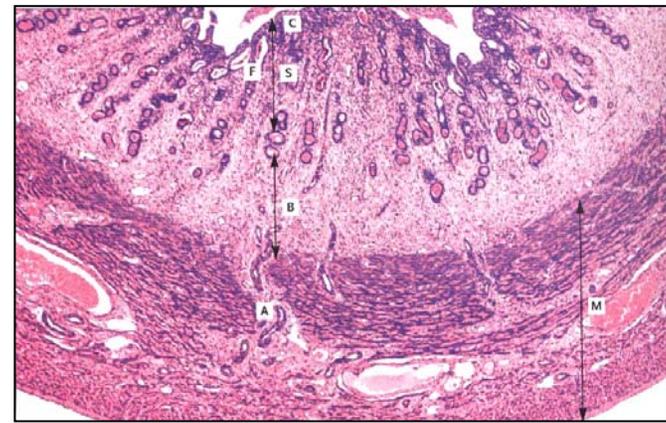
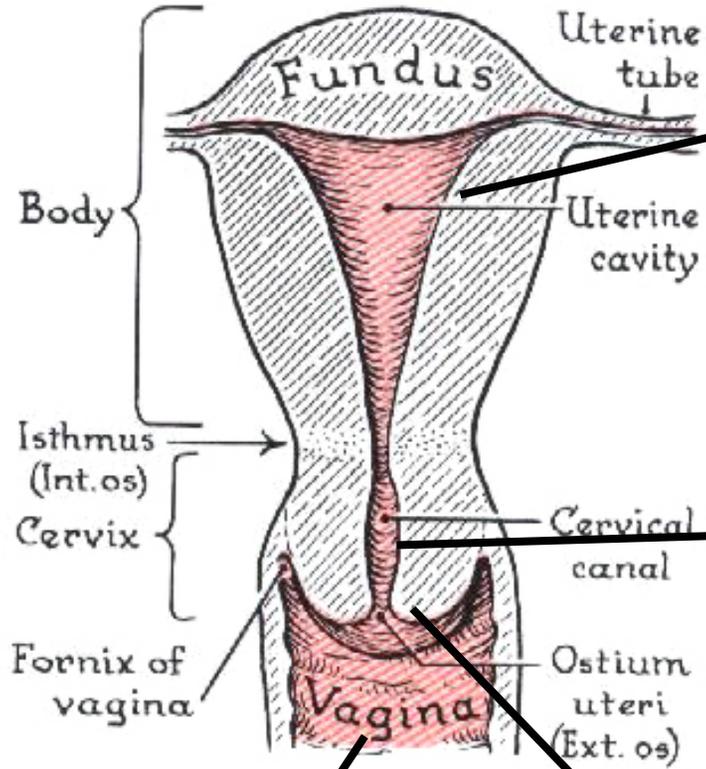
Gross anatomy of female genital organs-2



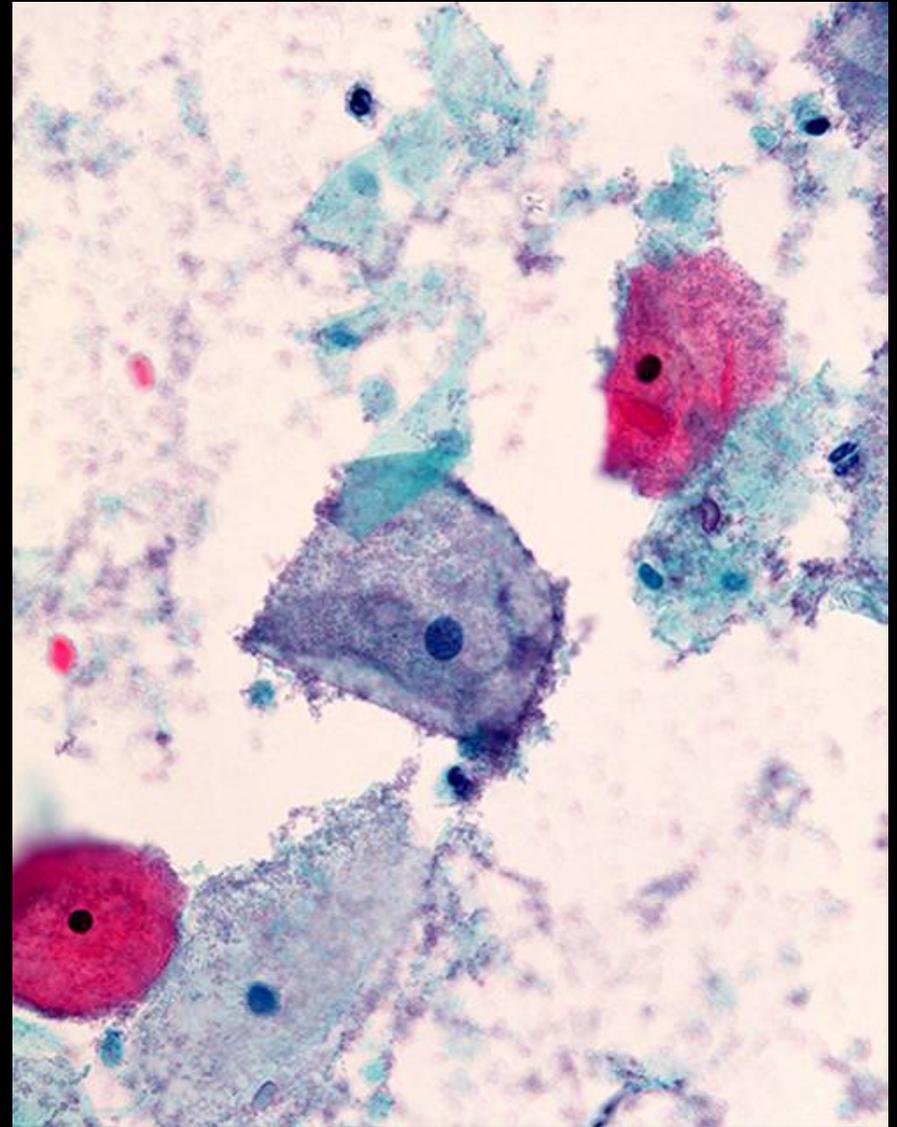
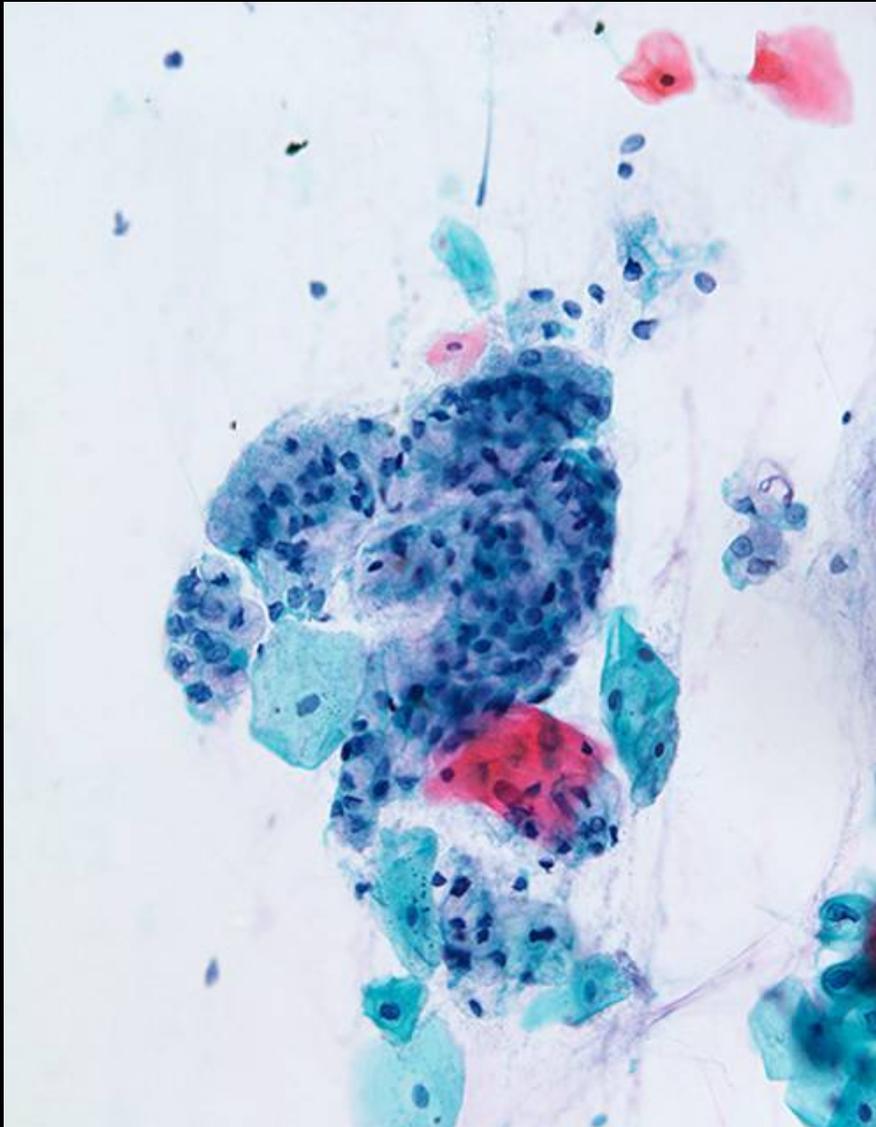
Development of female genital organs and tract

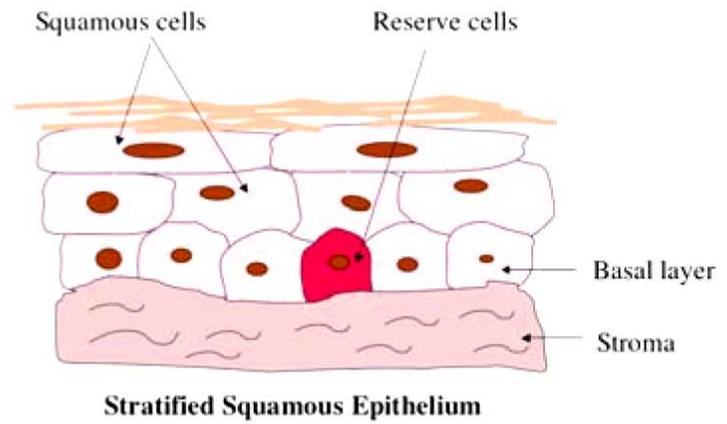
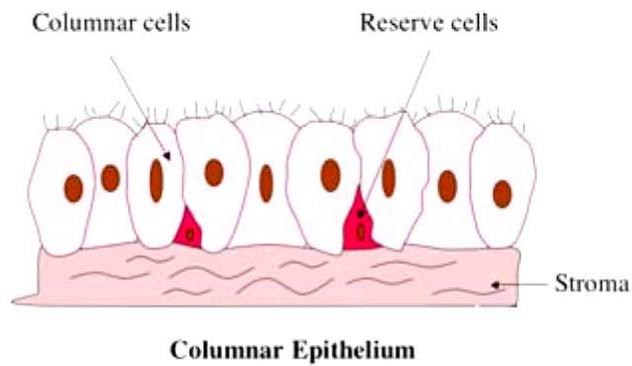


Histology



Normal Pap smear under microscopy

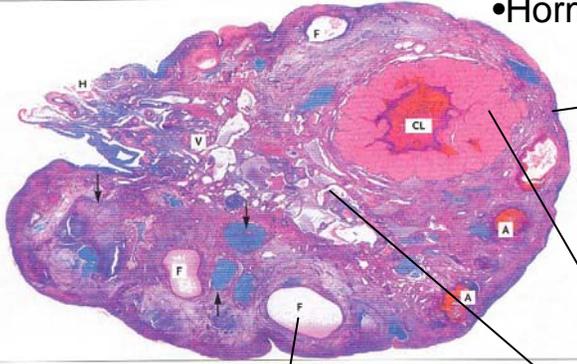




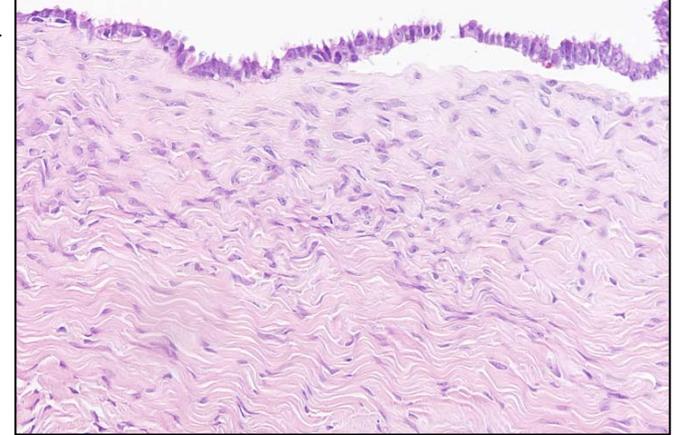
p63 +, c-kit +, $\alpha 6\beta 1$ integrin +

The Ovary

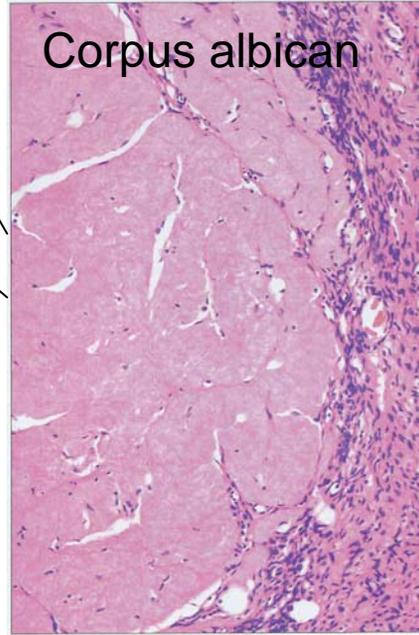
- Maturation of follicles
- Ovulation
- Hormonal organ



Ovarian surface and stroma



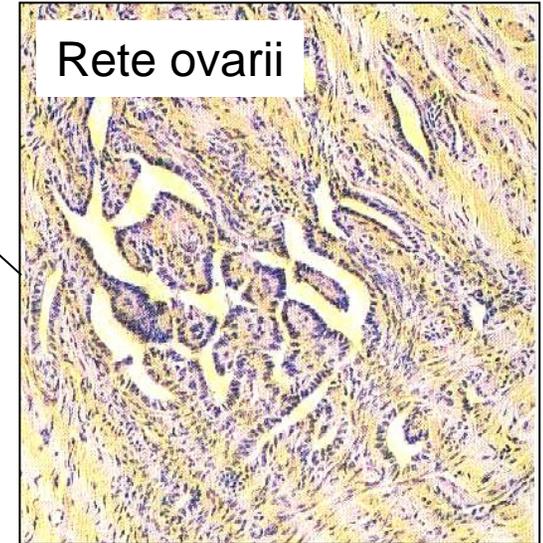
Corpus albicans



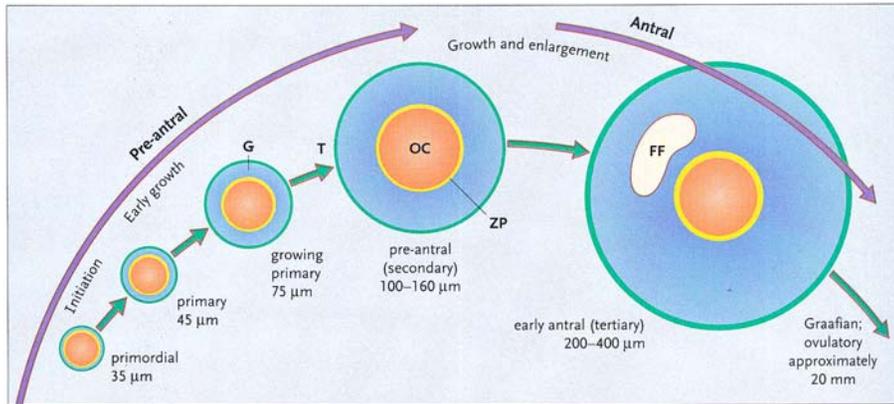
Follicles



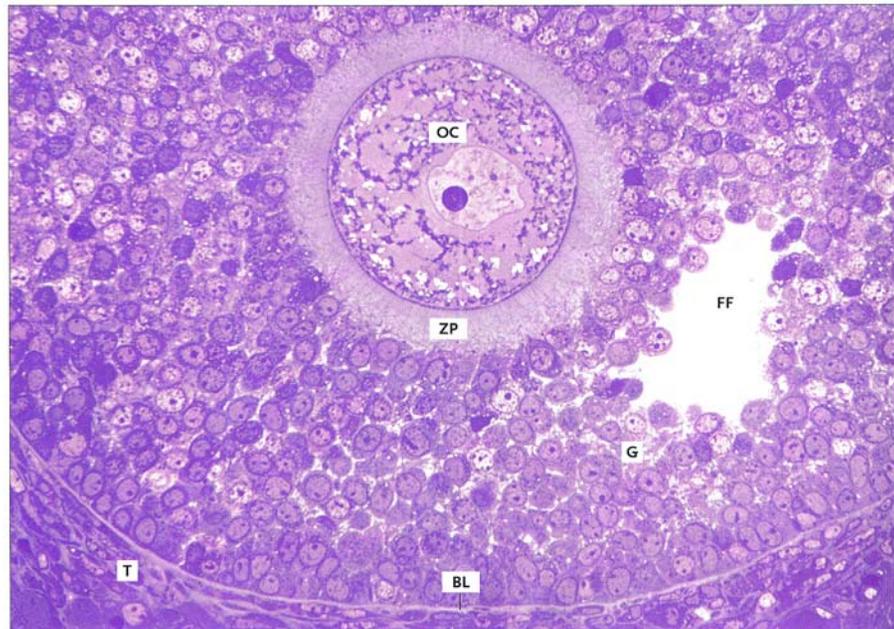
Rete ovarii



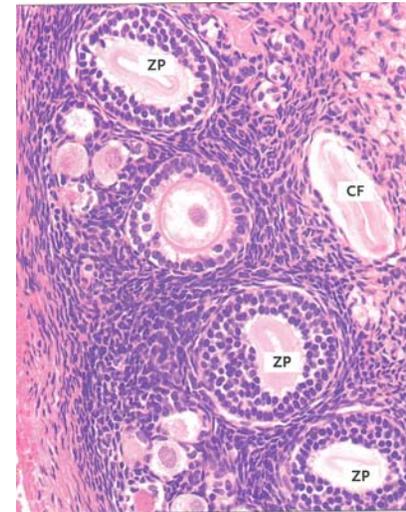
From follicle maturation to ovulation



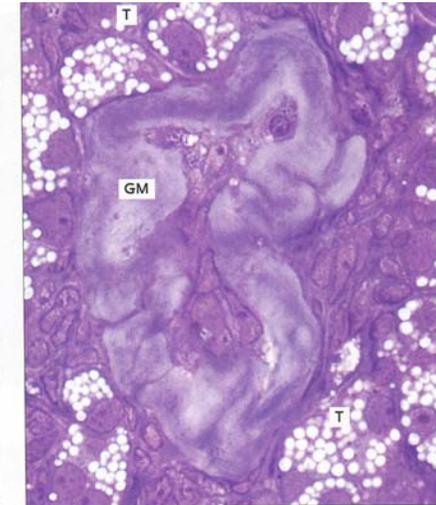
↑ Fig. 17.7 Growth of antral follicles. a Maturation and enlargement of ovarian follicles with average diameters for the various classes. The oocyte itself (OC) stabilizes at 80 μm in secondary follicles. Granulosa cells (G), zona pellucida (ZP), thecal layers (T), and antrum with follicular fluid (FF) are indicated.



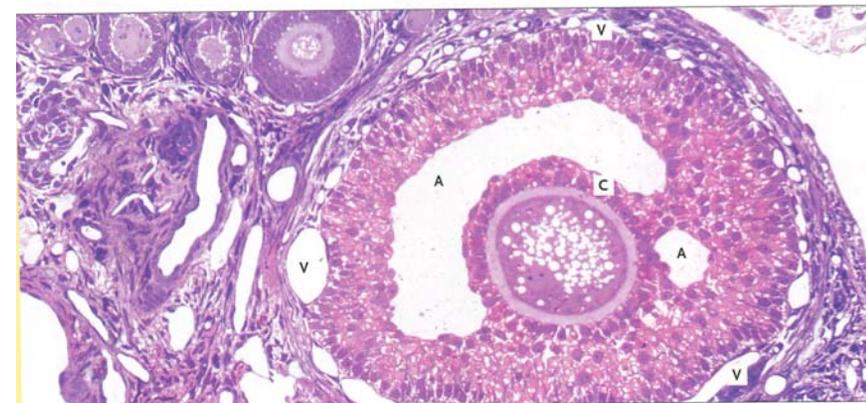
↑ Fig. 17.7b Early antral follicles show development of a cavity or antrum containing follicular fluid (FF). This is initially composed of proteoglycans and hyaluronan, synthesized by the granulosa cells (G) under stimulus from follicle-stimulating hormone. The oocyte (OC) shows a nucleus with nucleolus, and a cytoplasm rich in mitochondria and granules. The zona pellucida (ZP) forms a thick shell or coat surrounding the oocyte. A basal lamina (BL) marks the border between the follicle and the thecal (T) cell layer.



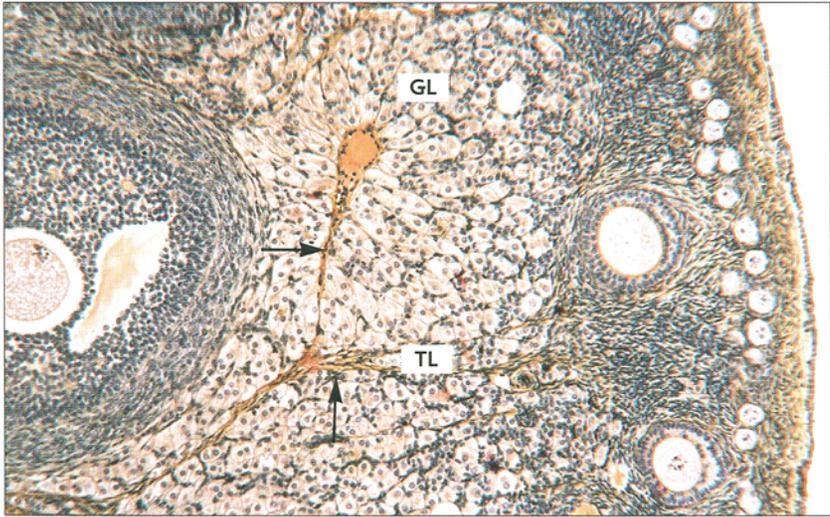
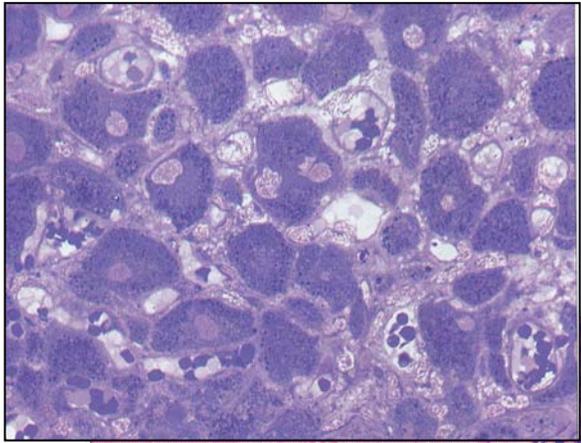
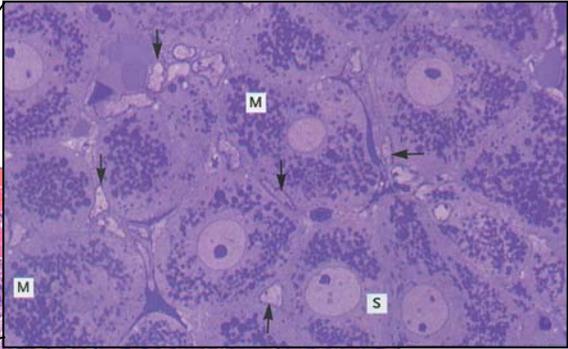
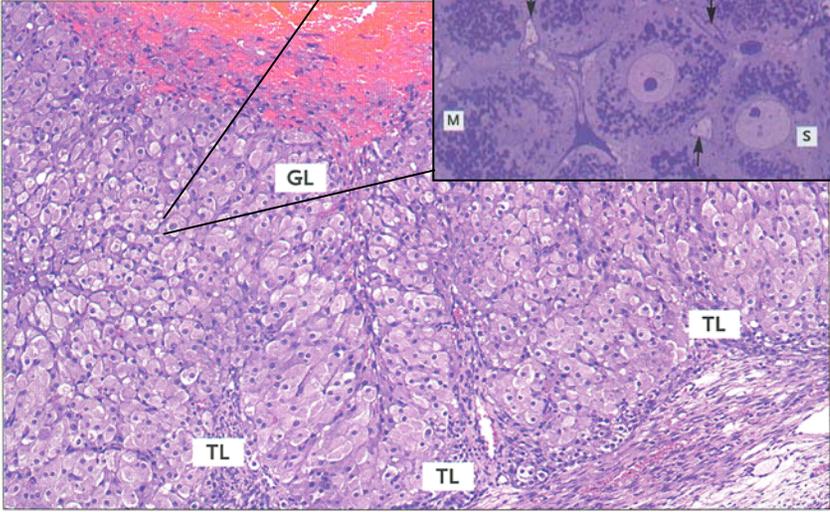
↑ Fig. 17.8 Atretic follicles. a Most follicles undergo degeneration or atresia and this can occur at any stage of oogenesis, although it is detected most frequently in antral follicles. Atretic pre-antral follicles quickly lose the oocyte, and the zona pellucida (ZP) is thickened and irregular. The end result is a hyalinized connective tissue mass, the corpus fibrosum (CF), which is resorbed. The cause or causes of pre-antral atresia are not known.



↑ Fig. 17.8b Antral follicles become atretic if their exposure or response to follicle-stimulating hormone (and intra-ovarian growth factors and estrogens) is inadequate to support growth. The oocyte degenerates and granulosa cells become apoptotic. In late stages, the follicle basal lamina is hyalinized into a wavy 'glassy membrane' (GM). Thecal cells (T) are luteinized and accumulate lipid inclusions. Ultimately all traces of the follicle disappear by resorption within the stroma.

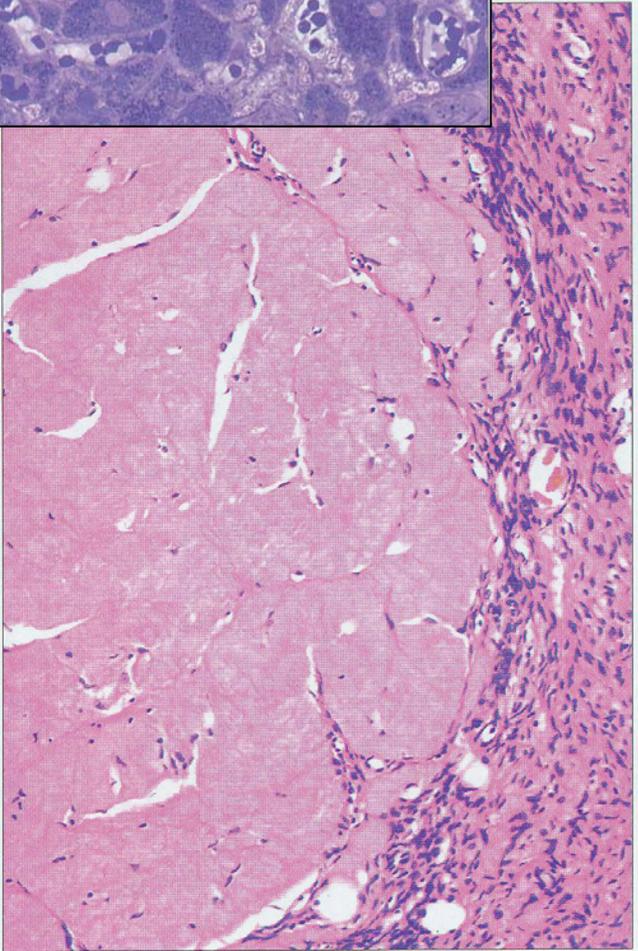
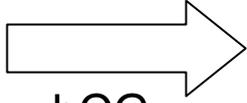


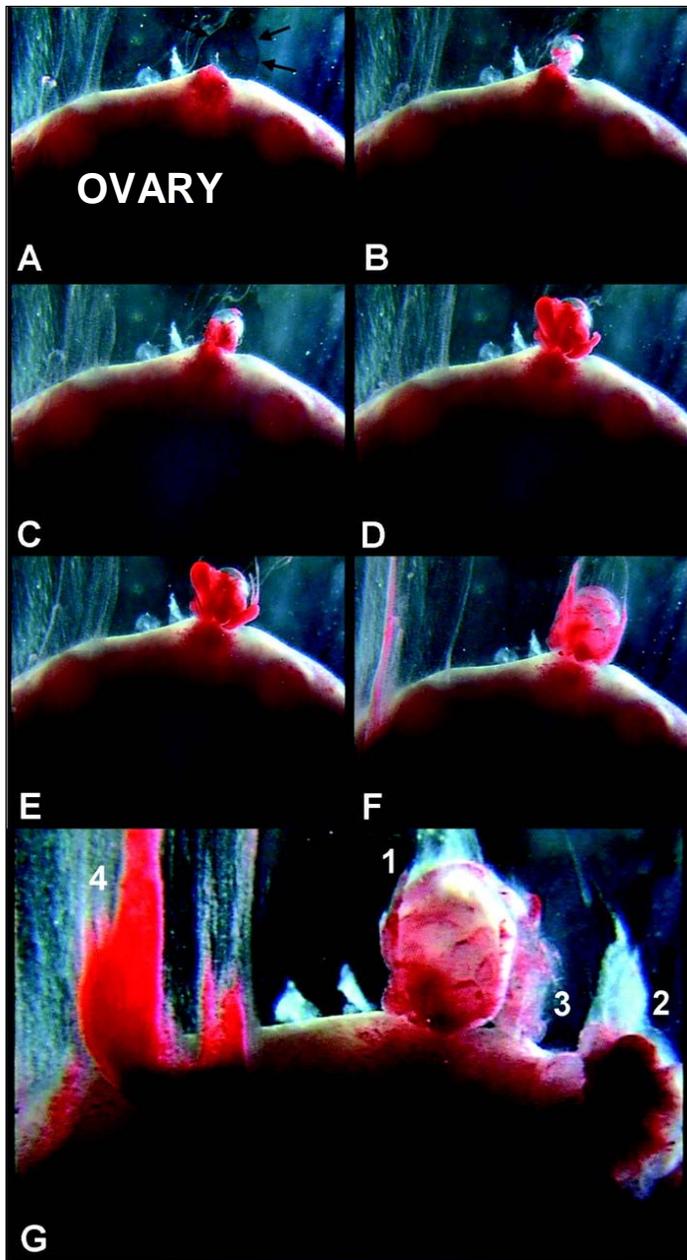
Corpus luteum-



No preg.

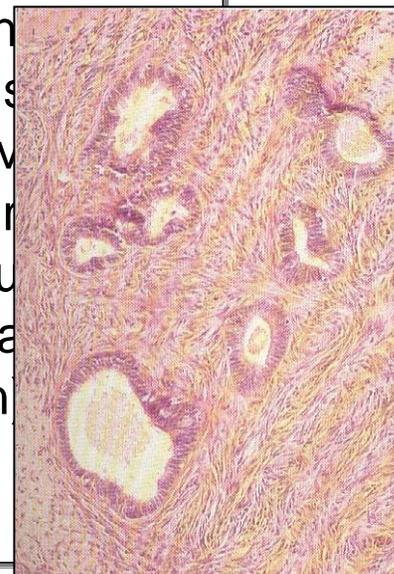
- hCG





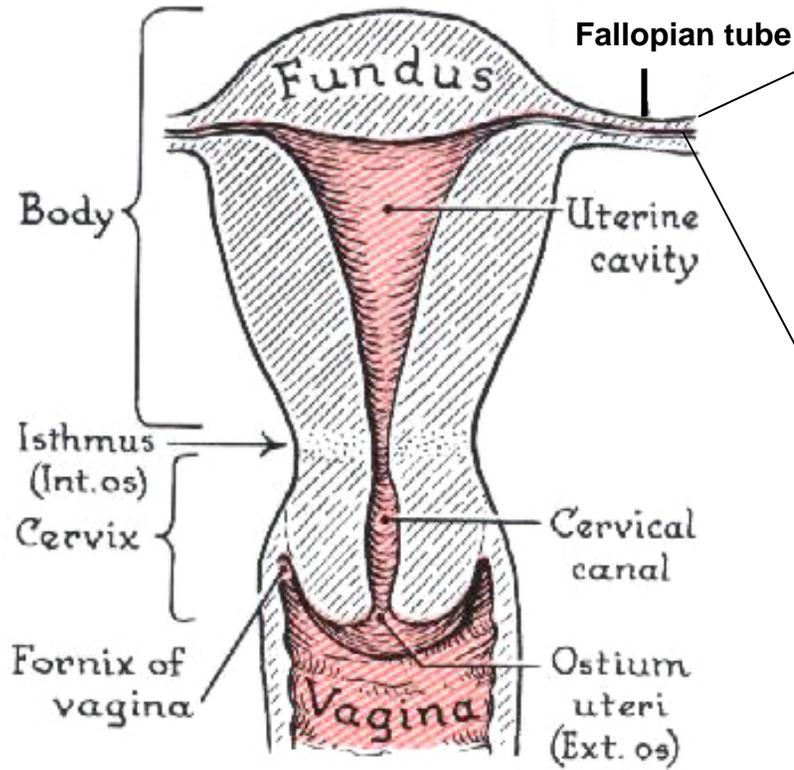
Sequences in ovulation in a rabbit ovary (from A to F).

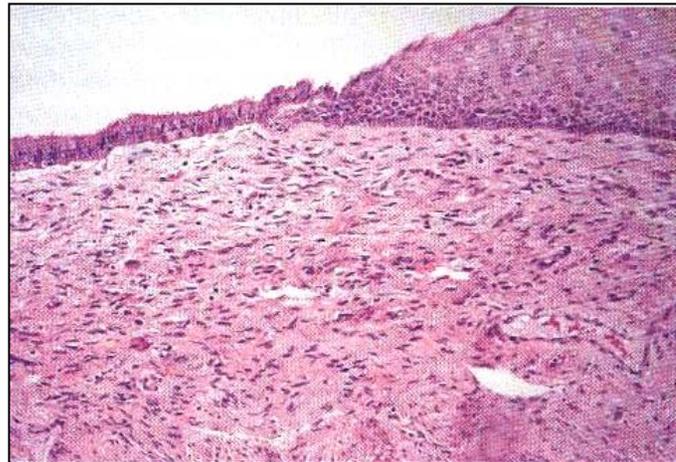
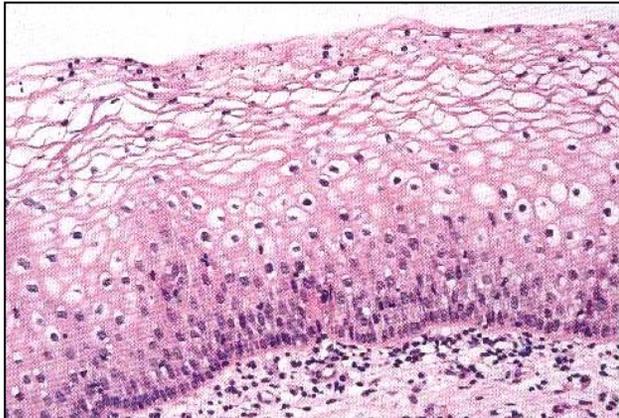
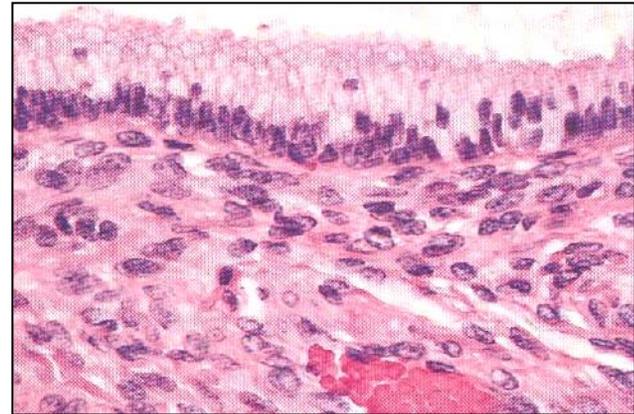
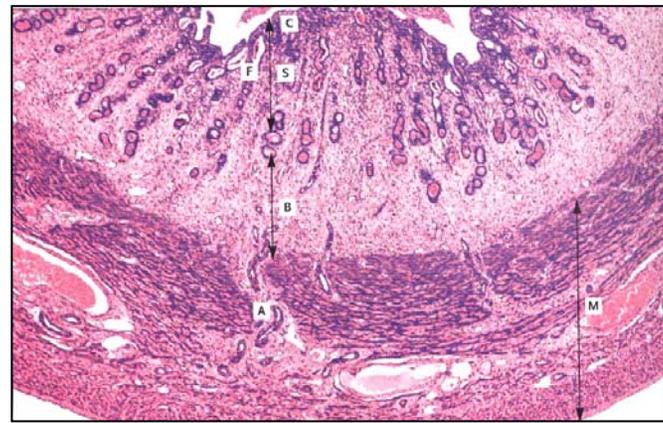
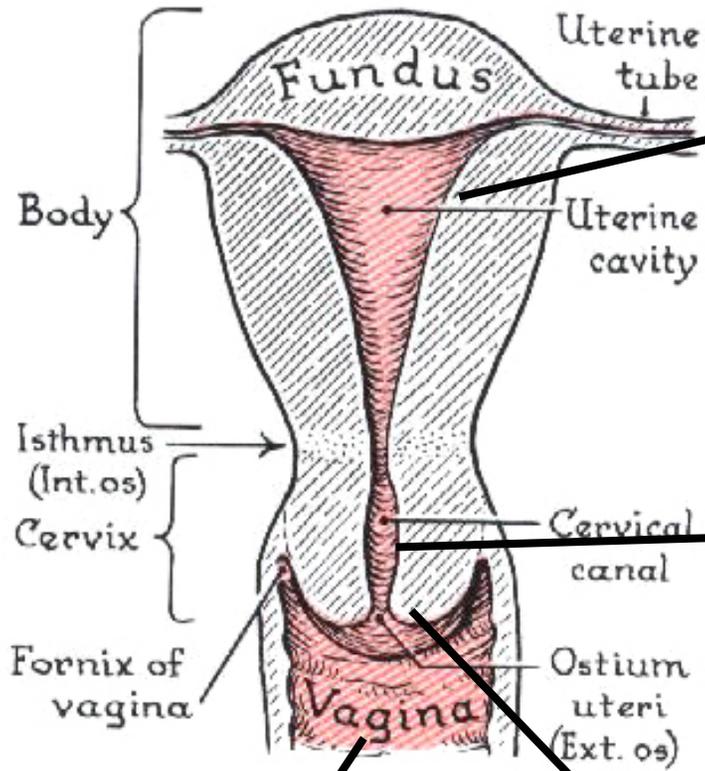
The photos were obtained from the reference: Follicle rupture in the rabbit ovary *in vivo* at the indicated times (A, 0 s; B, 5 s; C, 10 s; D, 55 s; E, 65 s; F, 545 s). The first sign of follicular rupture is follicular fluid leakage (A) and the margin of the follicular fluid front (arrows) is clearly seen. Then the extrusion of the granulosa cells is initiated (B) and within seconds is accompanied by blood extrusion (C-F). Panel G represents an ovary of the rabbit ovary 2.5 h after rupture. These ruptures occur in the order 1–4 (1 at 0 min; 2 at 1 min; 3 at 54 min; 4 at 96 min).



Fallopian tube

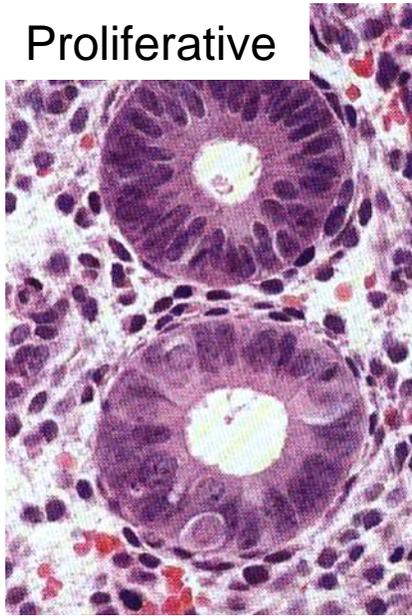
- a muscular tube that connects uterus and ovaries
- ciliated cells and secretory cells
- where fertilization takes place



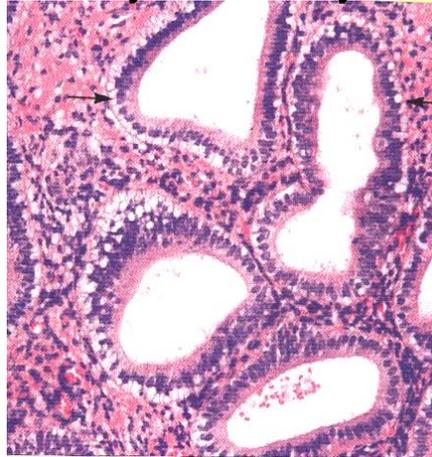


The human menstrual cycle

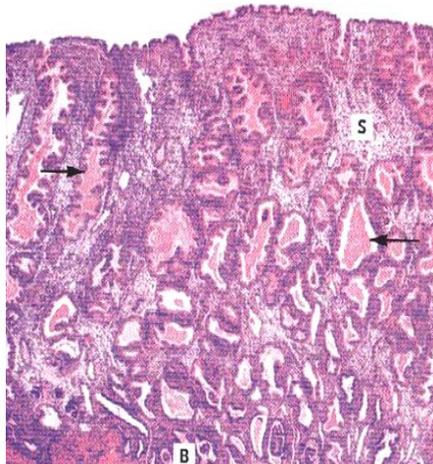
Proliferative



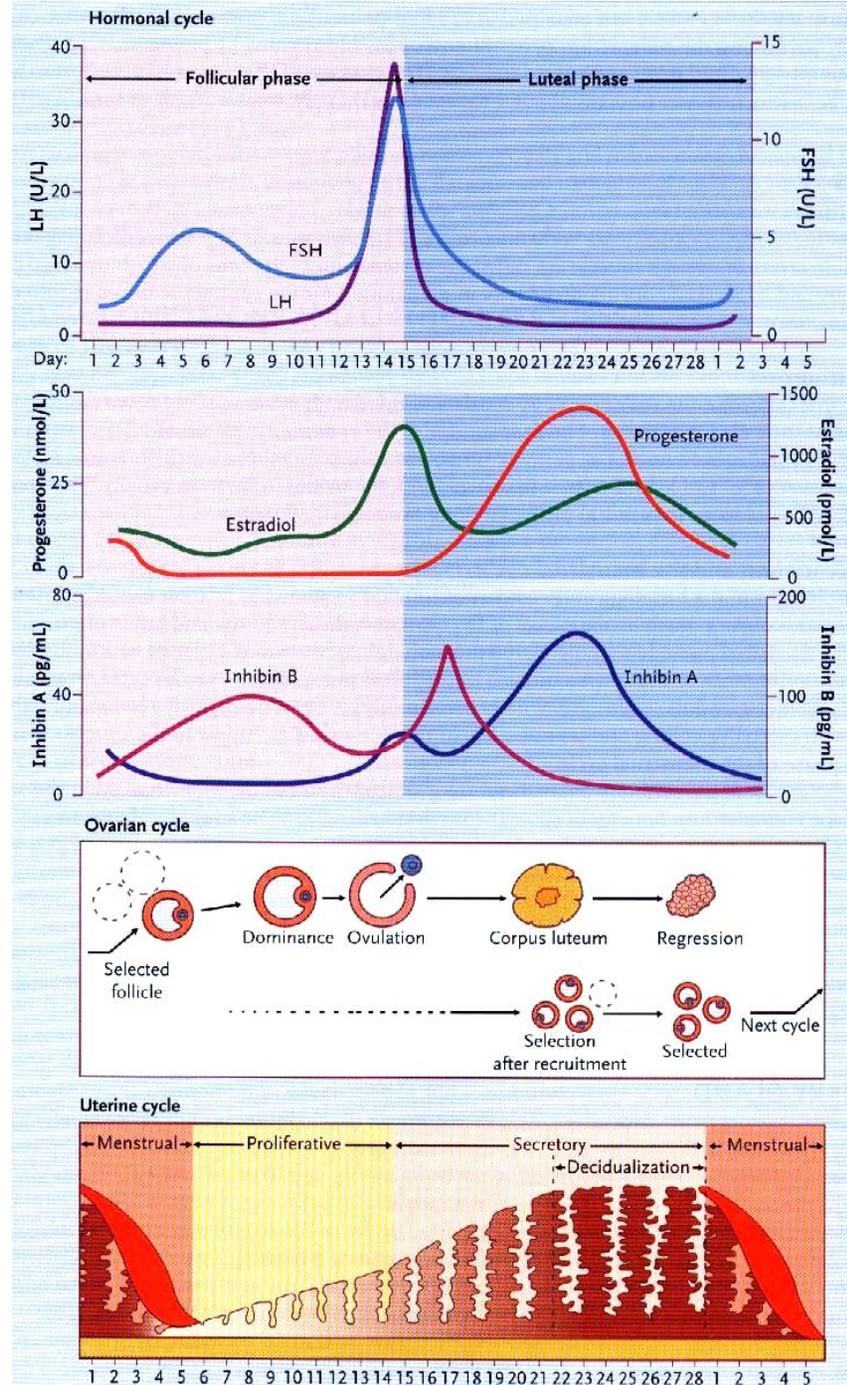
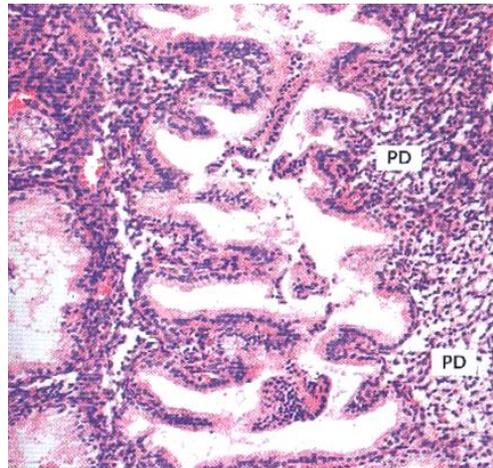
Early secretory



Mid Secretory



Late secretory



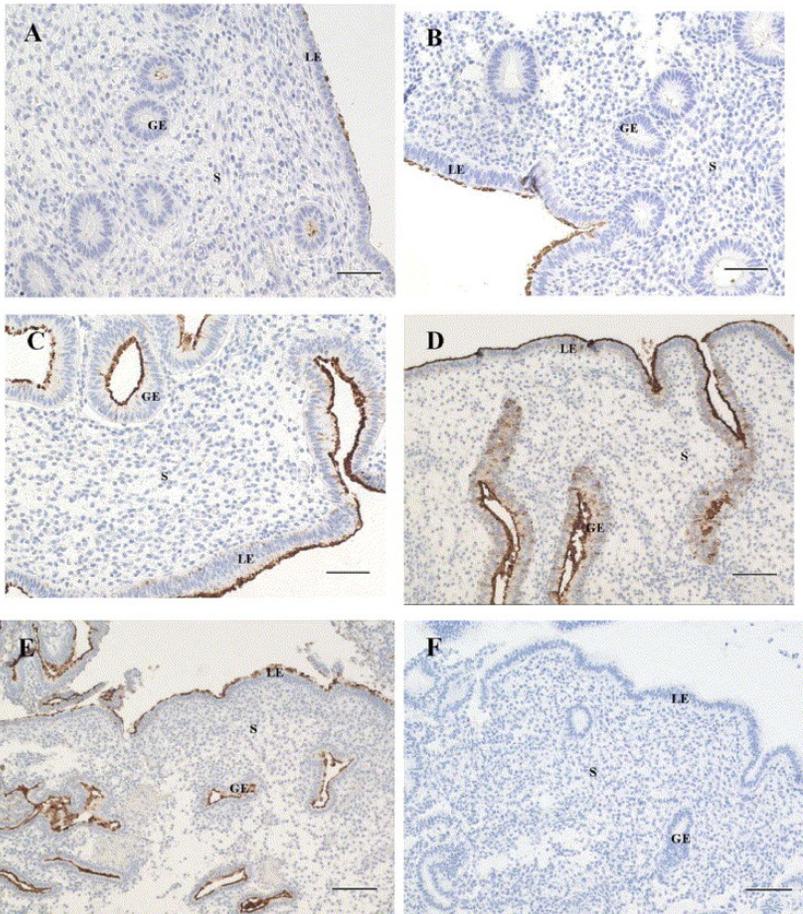
Fertility and Sterility

Volume 83, Issue 4, Supplement 1 , Pages 1297-1302

Differential expression of L-selectin ligand in the endometrium during the menstrual cycle.

- Lai TH,
- Shih leM,
- Vlahos N,
- Ho CL,
- Wallach E,
- Zhao Y.

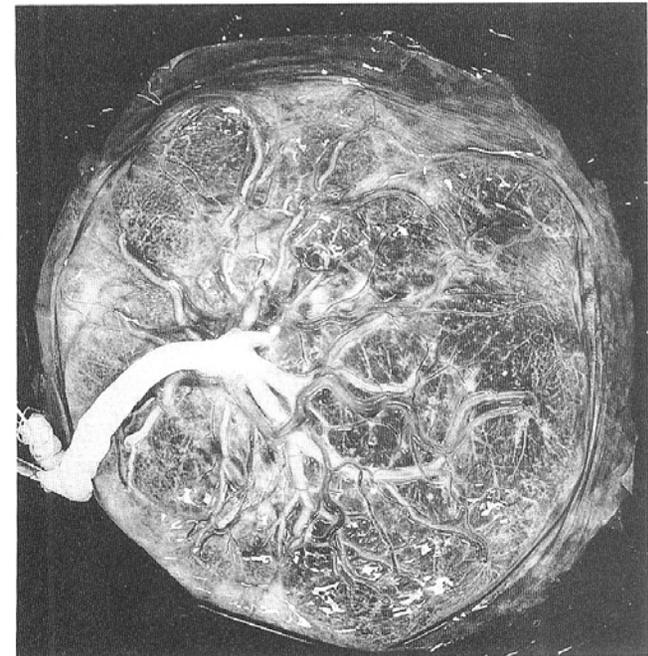
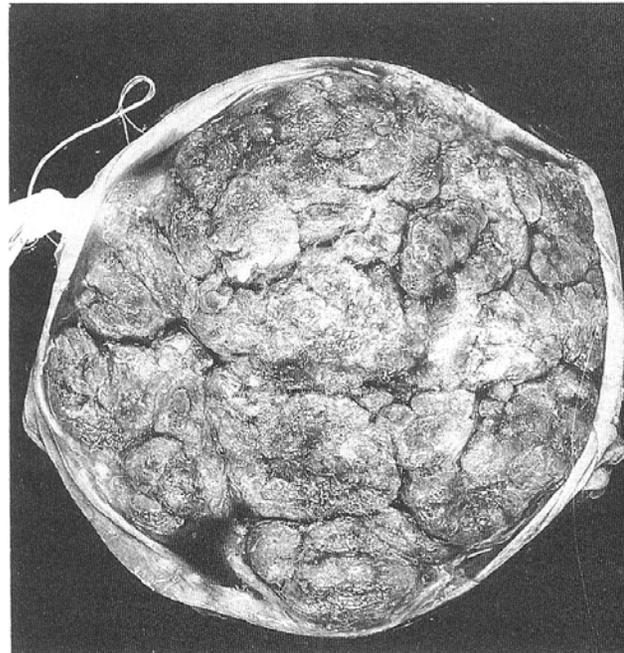
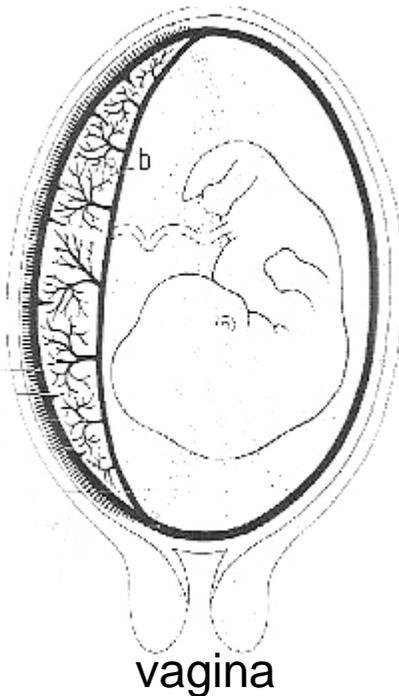
Department of Gynecology and Obstetrics, Johns Hopkins University School of Medicine, Baltimore, MD 21287, USA.



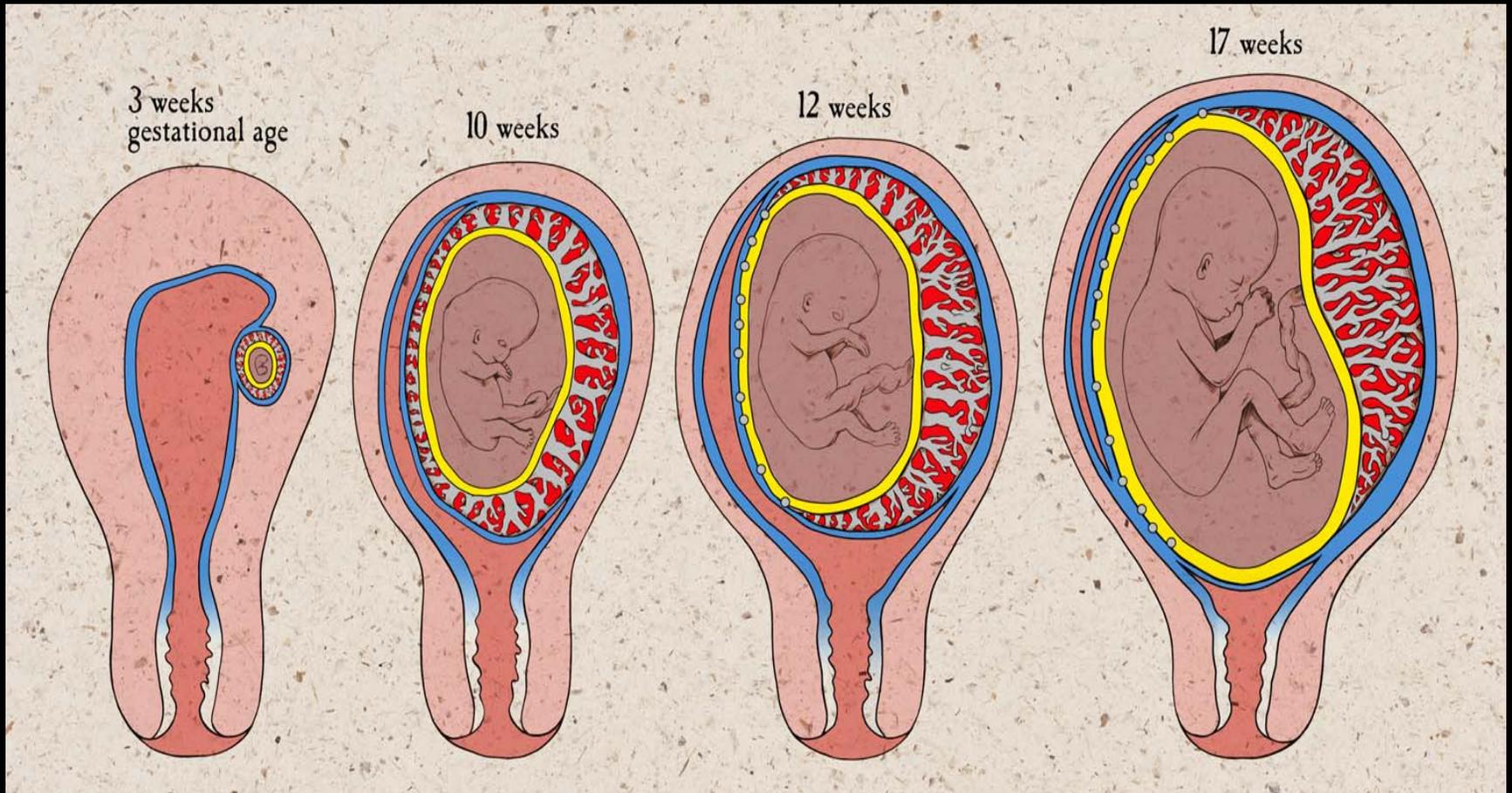
Increased expression of L-selectin ligand in the human endometrium during the early and midsecretory phases of the menstrual cycle may be related to the process of implantation.

Human placenta-

- Fetal structure to support gestation
- Maternal-fetal interface for molecular exchanges
- Hormonal organ
- Barrier of maternal immune response
- Physical protector of fetus



Development of human placenta



Anatomy of Early Placenta

Cytotrophoblast

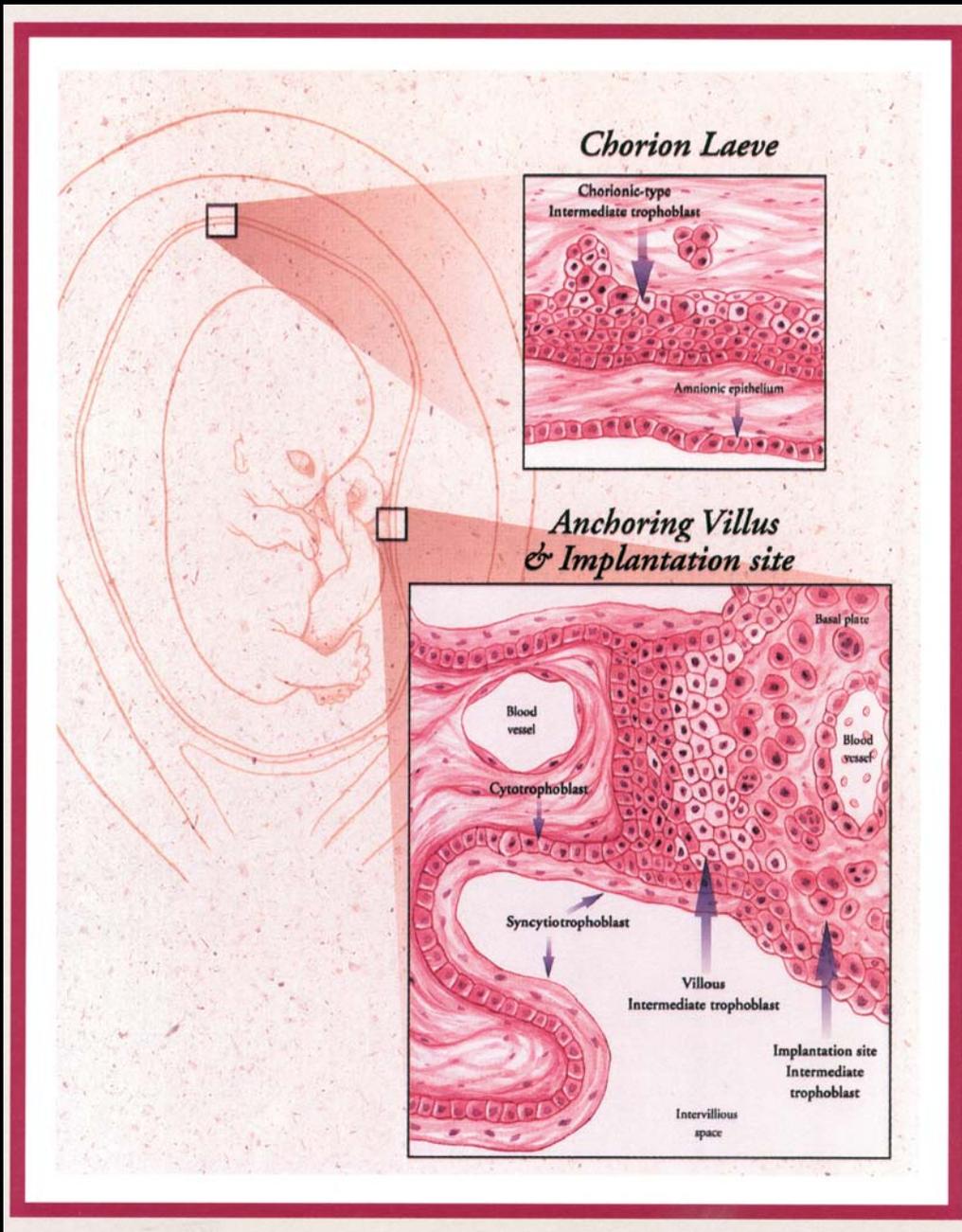
Stem cell

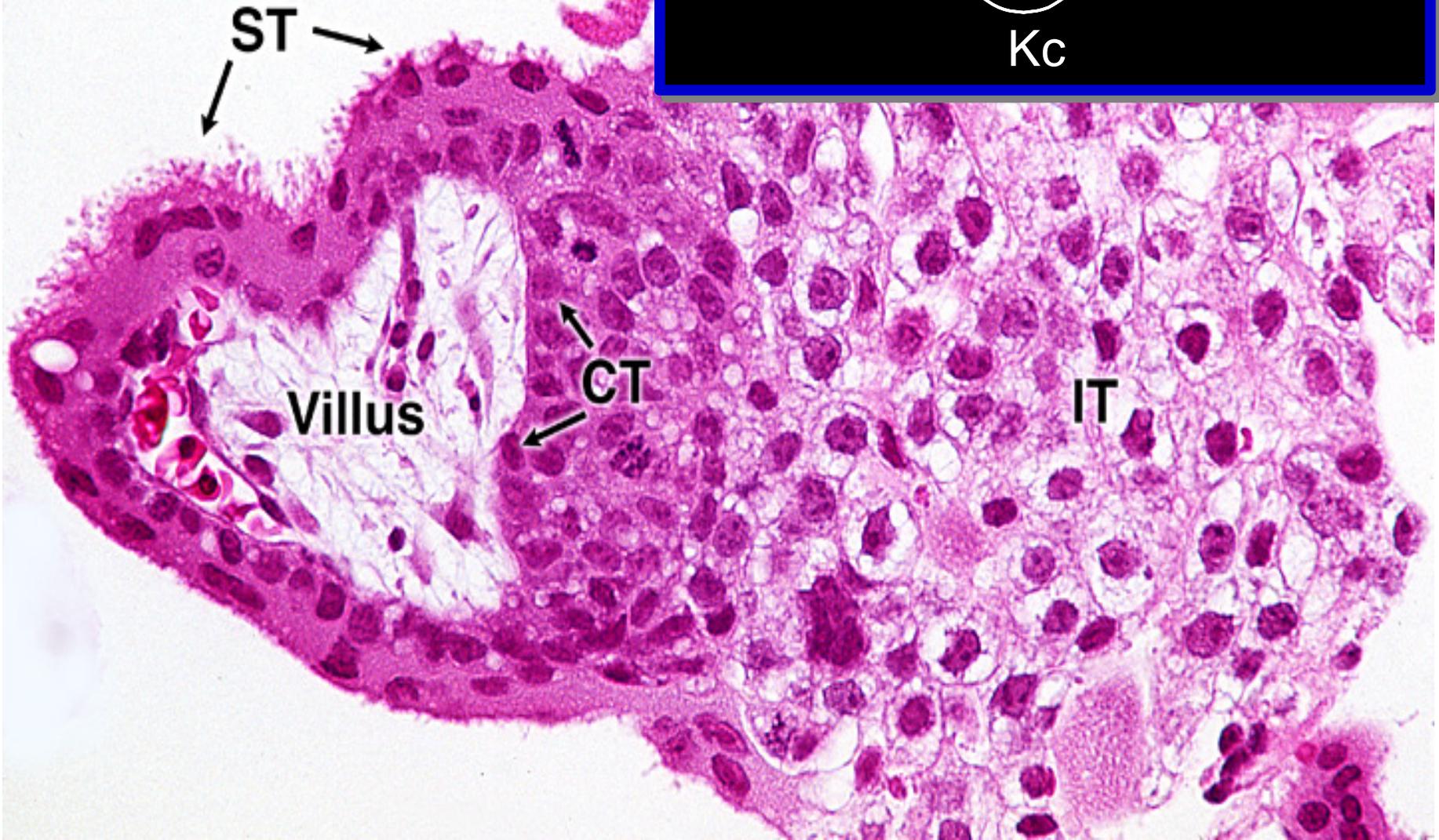
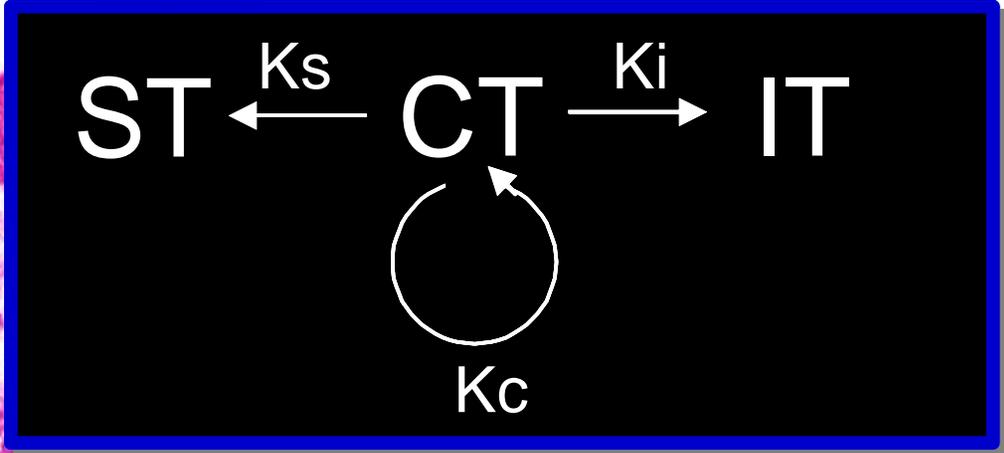
Syncytiotrophoblast

Hormone, transport

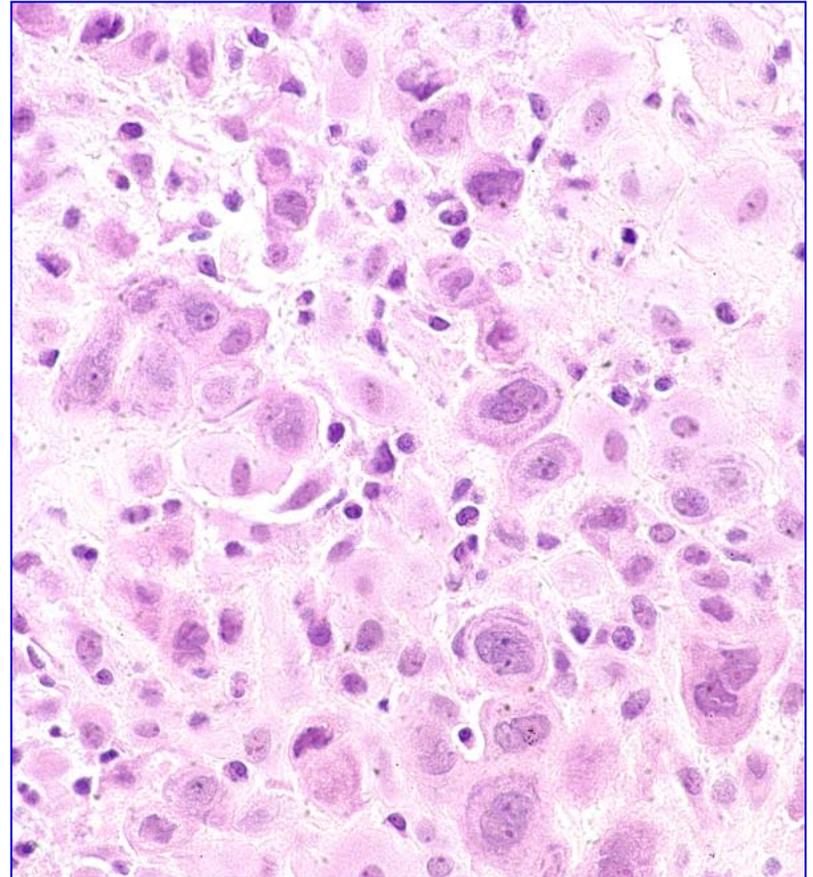
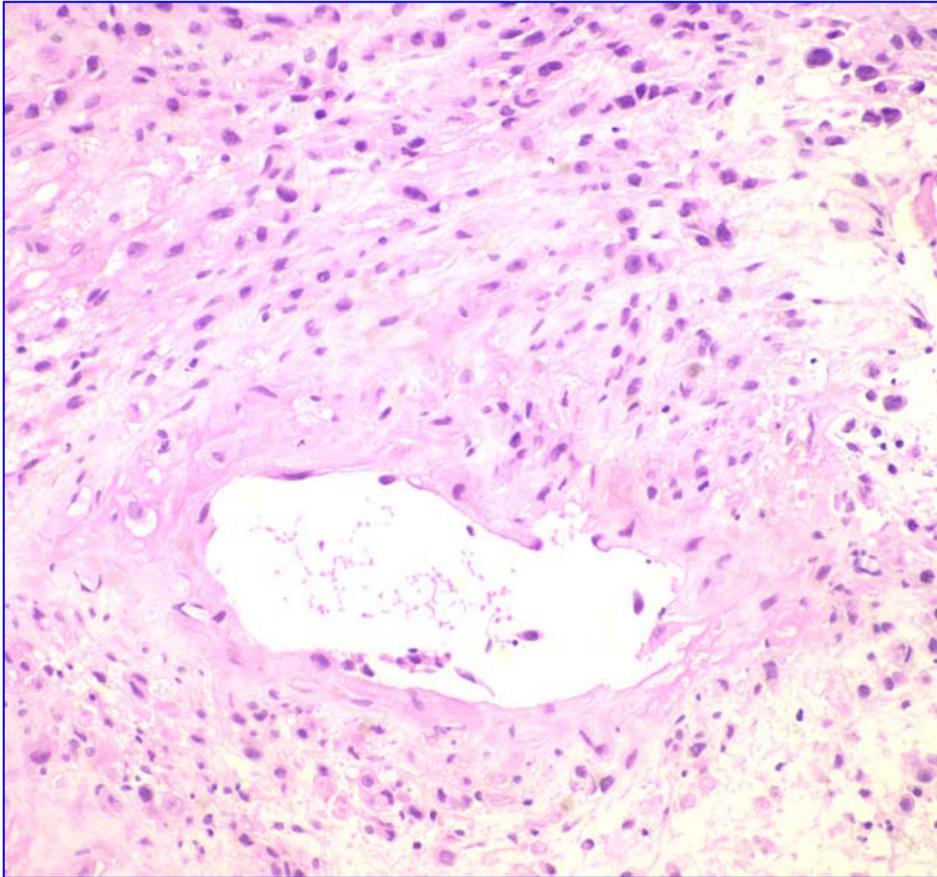
Intermediate trophoblast

Invasion, attack SA
drain blood to
intervillous space

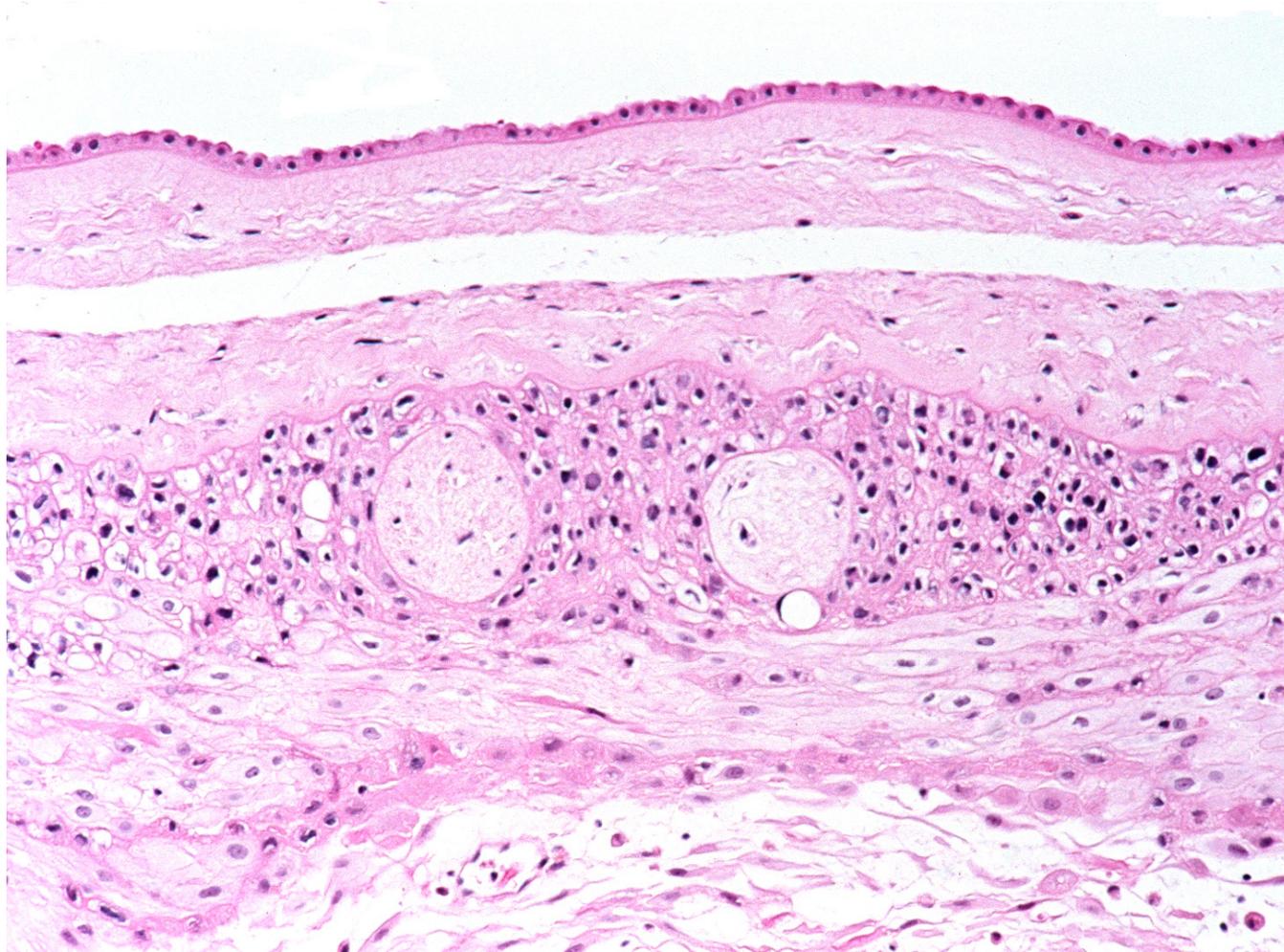




Intermediate trophoblastic cells in an implantation site



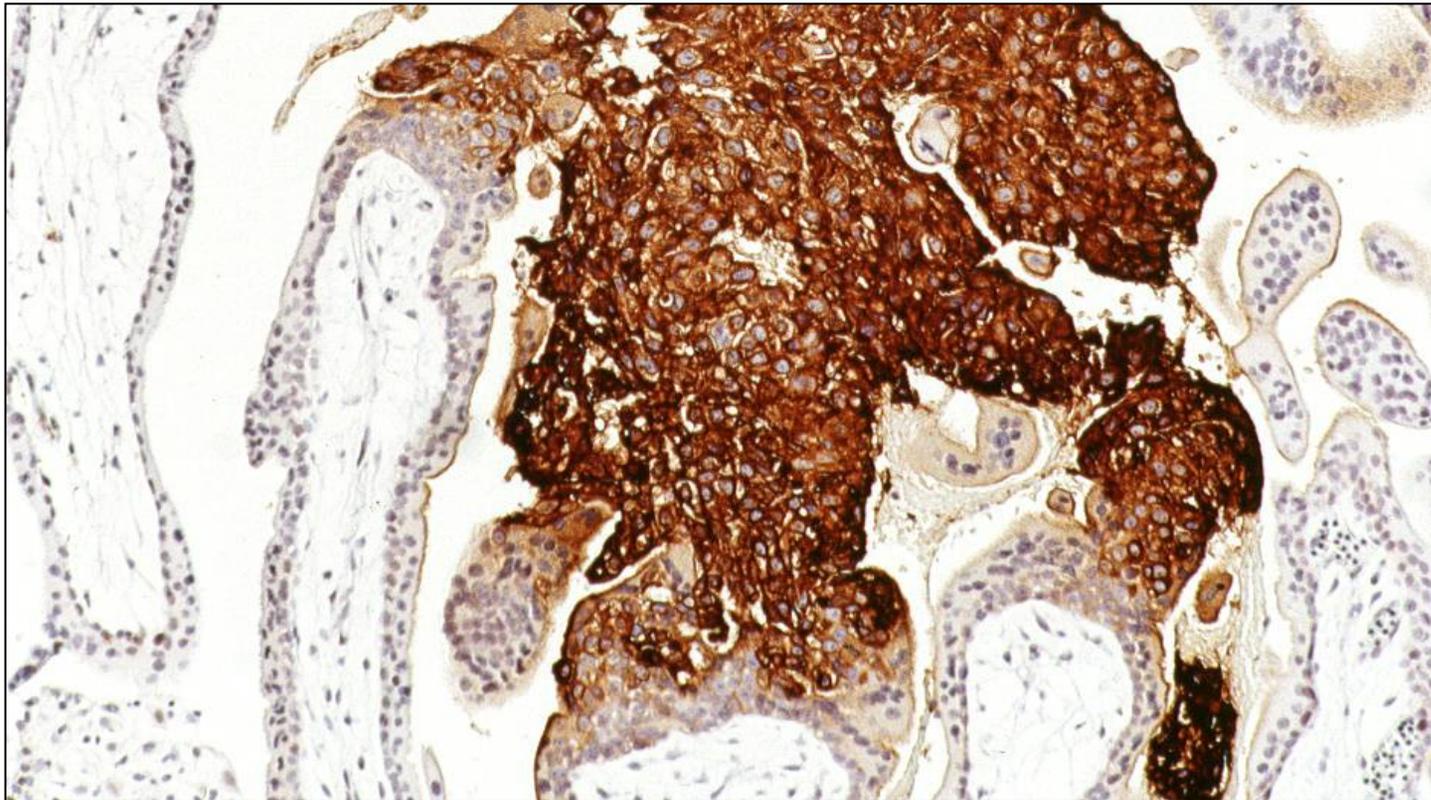
Fetal membrane- Chorion laeve



- Amnion Epithelium
- Amnion Stroma
(Chorion Epithelium)
- Chorion Stroma
- Intermediate
Trophoblast
- Decidua
(parietal layer)

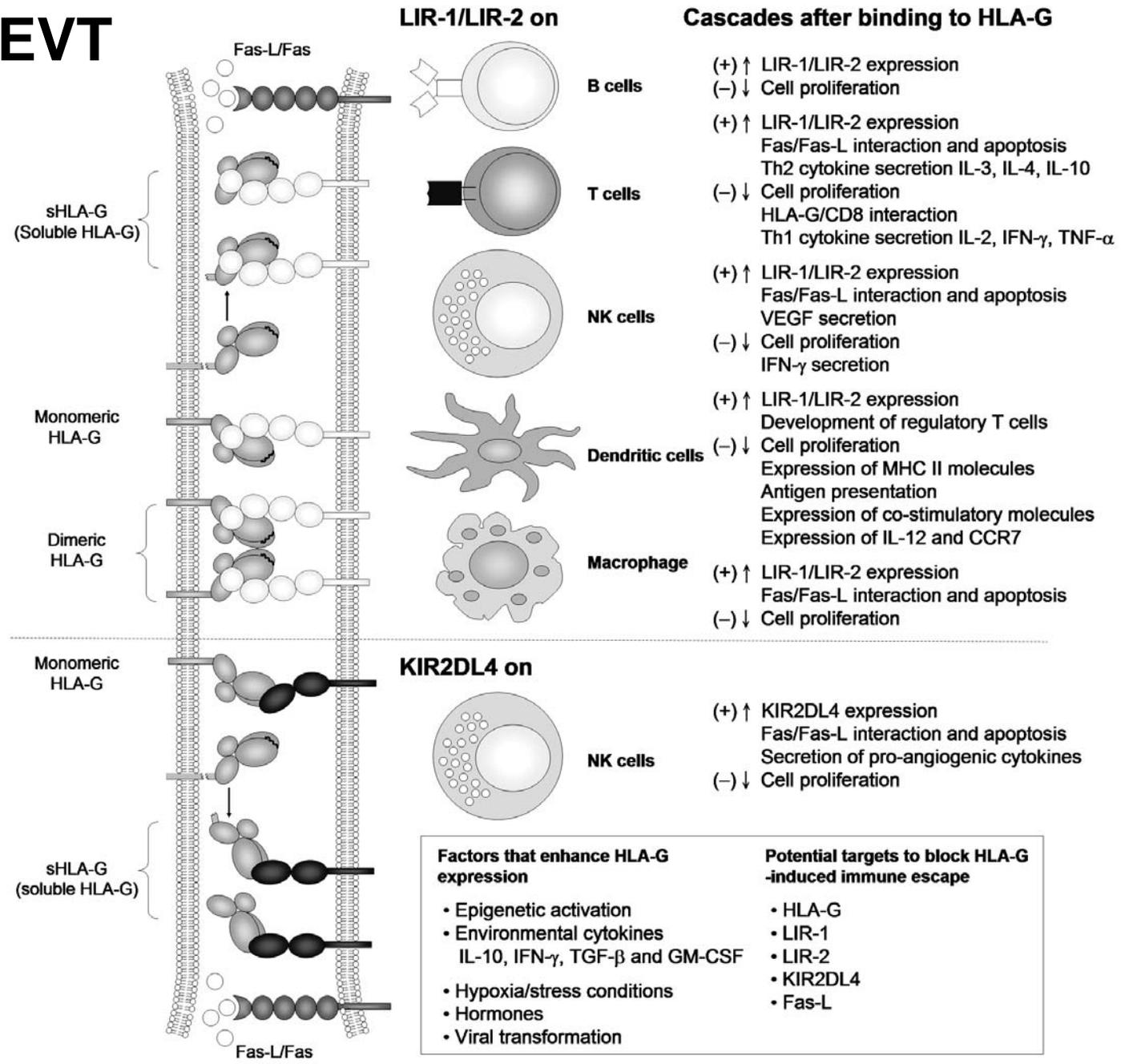
HLA-G expression in human placenta

- Cell surface MHC class II protein involved in immune response
- Very limited tissue distribution- trophoblast
- Expressed in human cancer including renal cell ca, melanoma, ovarian ca, large cell lung ca
- Contain secretory (G5) isoform that suppresses functions of immune cells such as T-cell and NK cells in the implantation site

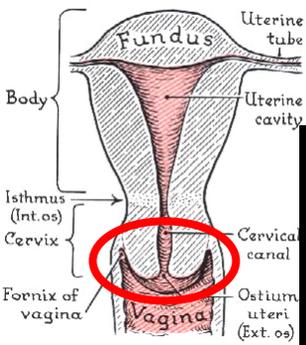


How HLA-G facilitates immune escape?

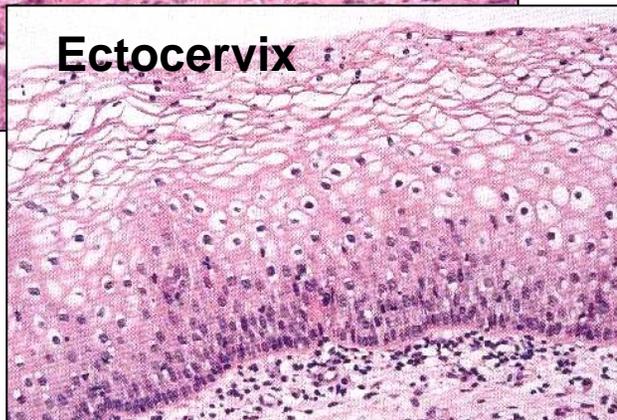
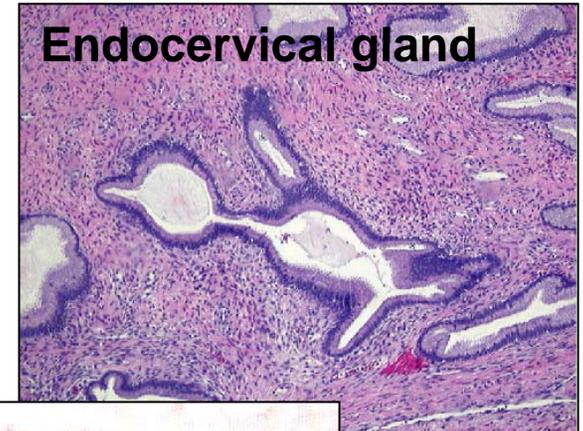
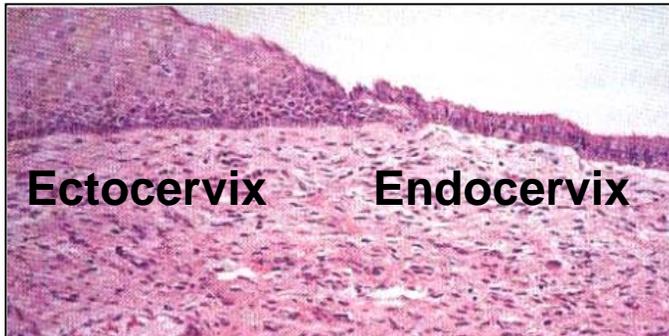
EVT



Uterine cervix



- The check point of vaginal bacterial flora
- Secrete mucin to control bacterial growth in vagina
- Stopper for conceptus before term (prevent preterm labor)



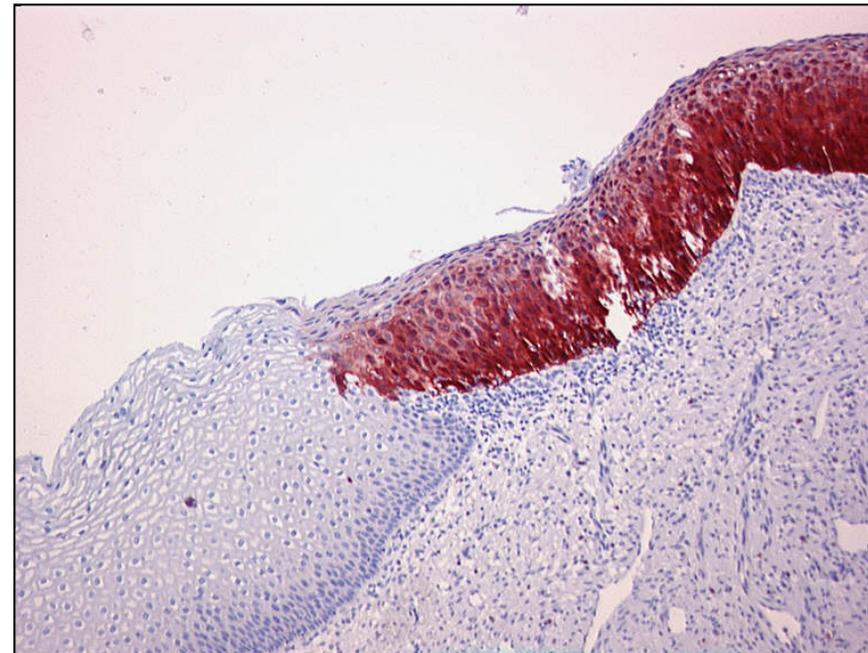
Principles of HPV E6 / E7 Oncogene Activity

- E7 binds to RB-P which results in release of E2F transcription factors



inactivation of RB and release of E2F

Inactivation of RB results in marked overexpression of p16ink4a



(Klaes et al., Int.J. Cancer 92, 276-284, 2001)
(Sano et al., Am.J.Pathol. 153, 1741-1748, 1998)

Pathology of female reproductive system

Ovaries- neoplastic diseases, cysts (torsion), endometriosis, hemorrhagic corpus luteum, hormonal imbalance

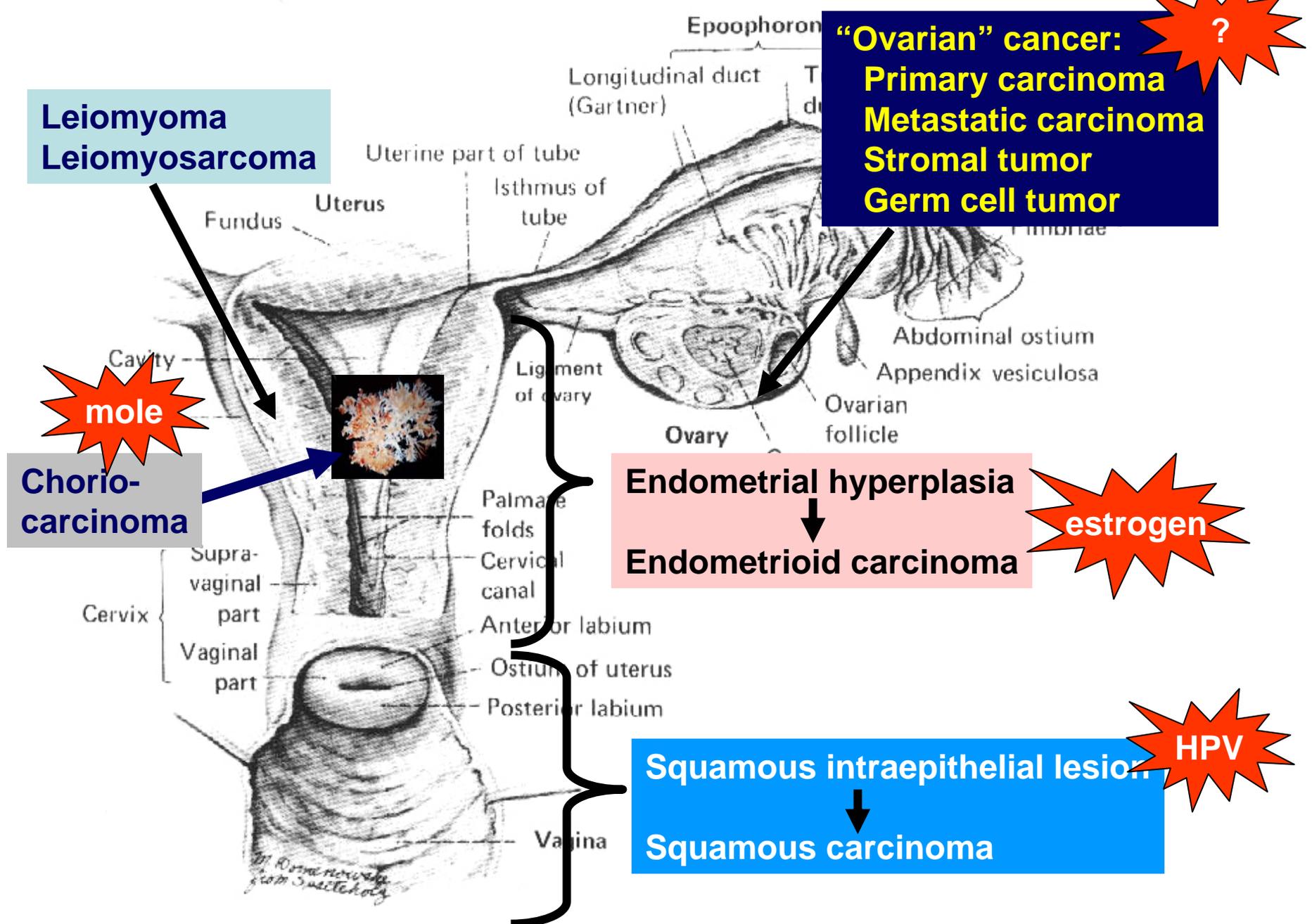
Fallopian tubes- infection, tubal pregnancy, neoplastic disease

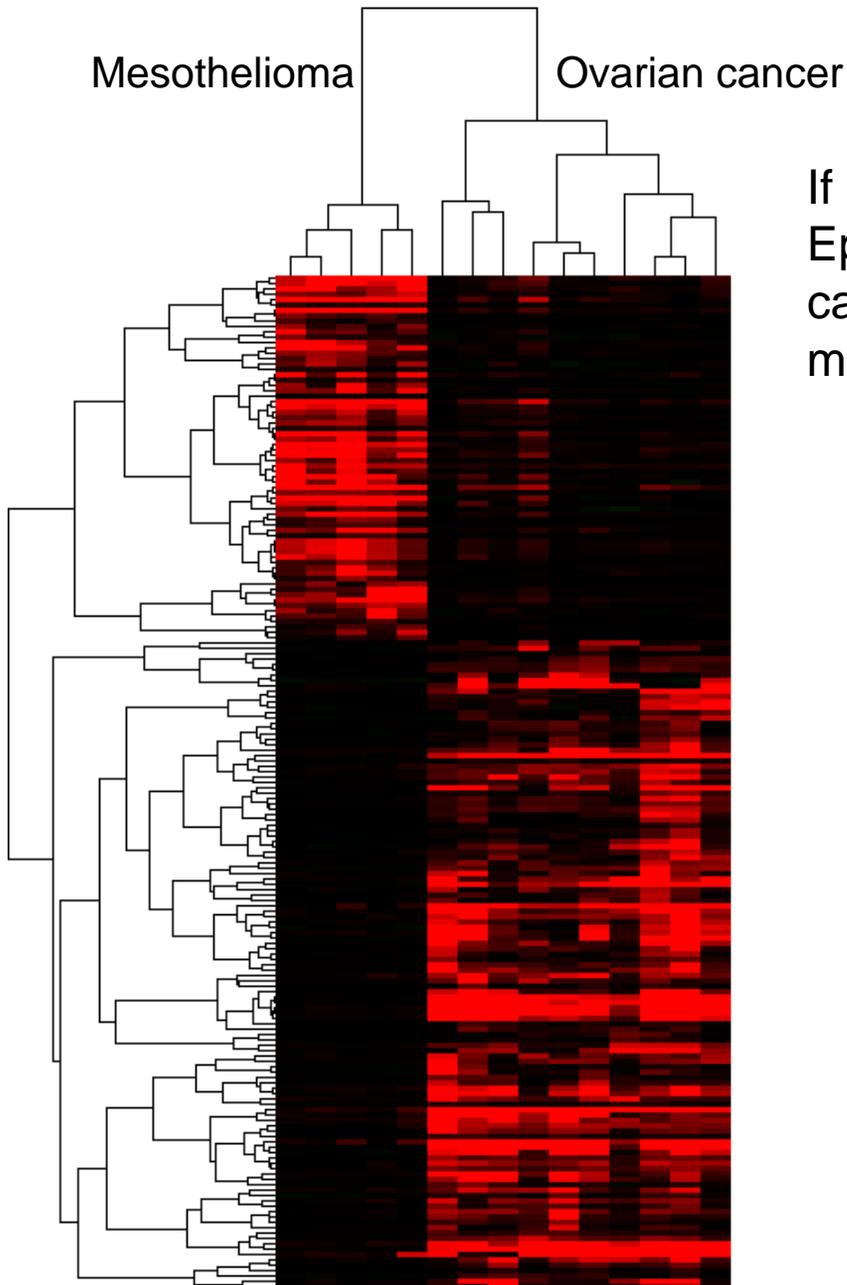
Uterus corpus- neoplastic disease, hyperplasia, functional bleeding, infection

Lower genital tract (vagina and vulva)- neoplastic disease (HPV related)

Placenta- abnormality (molar pregnancy), infection, placental dysfunction, neoplastic disease (rare)

Gross anatomy of female genital organs

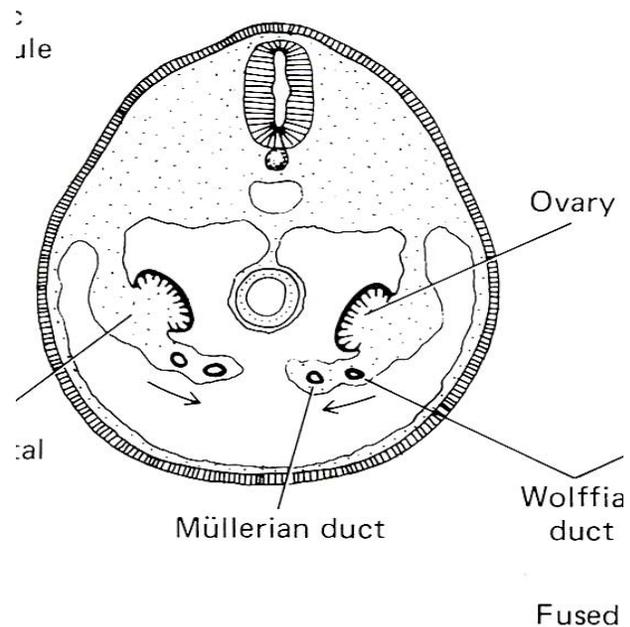




Affymetrix U133 Plus 2.0 microarrays

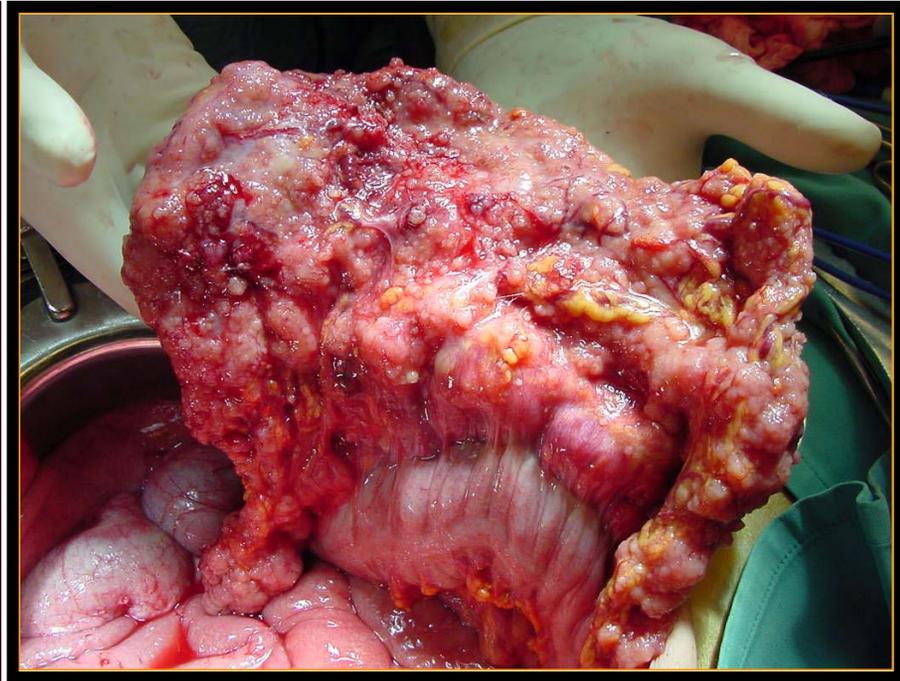
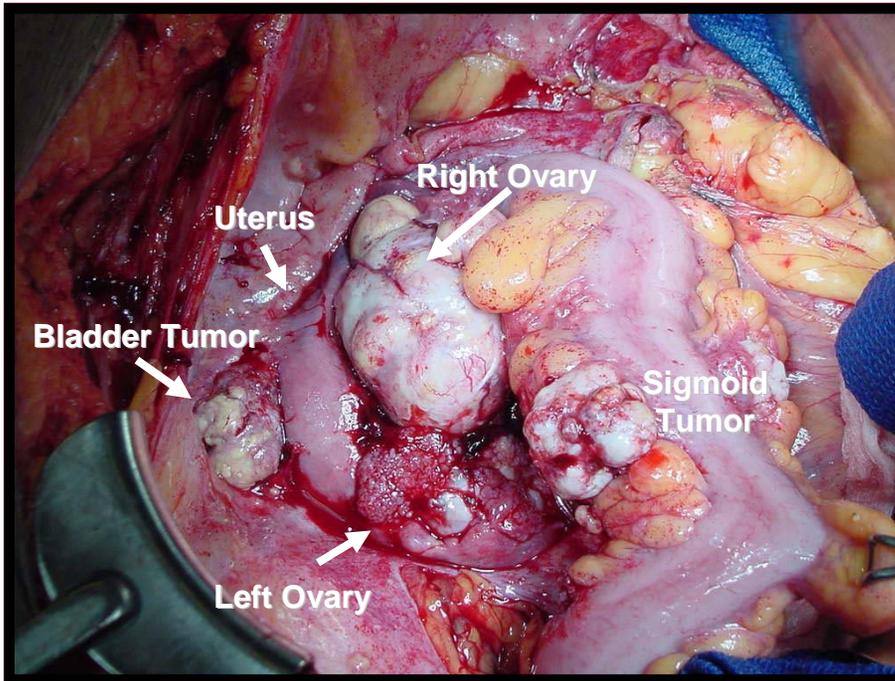
If ovarian cancer is derived from ovarian surface Epithelial cells, i.e., mesothelial cells, ovarian cancer should resemble mesothelioma morphologically and molecularly.

Other origin of ovarian cancer?

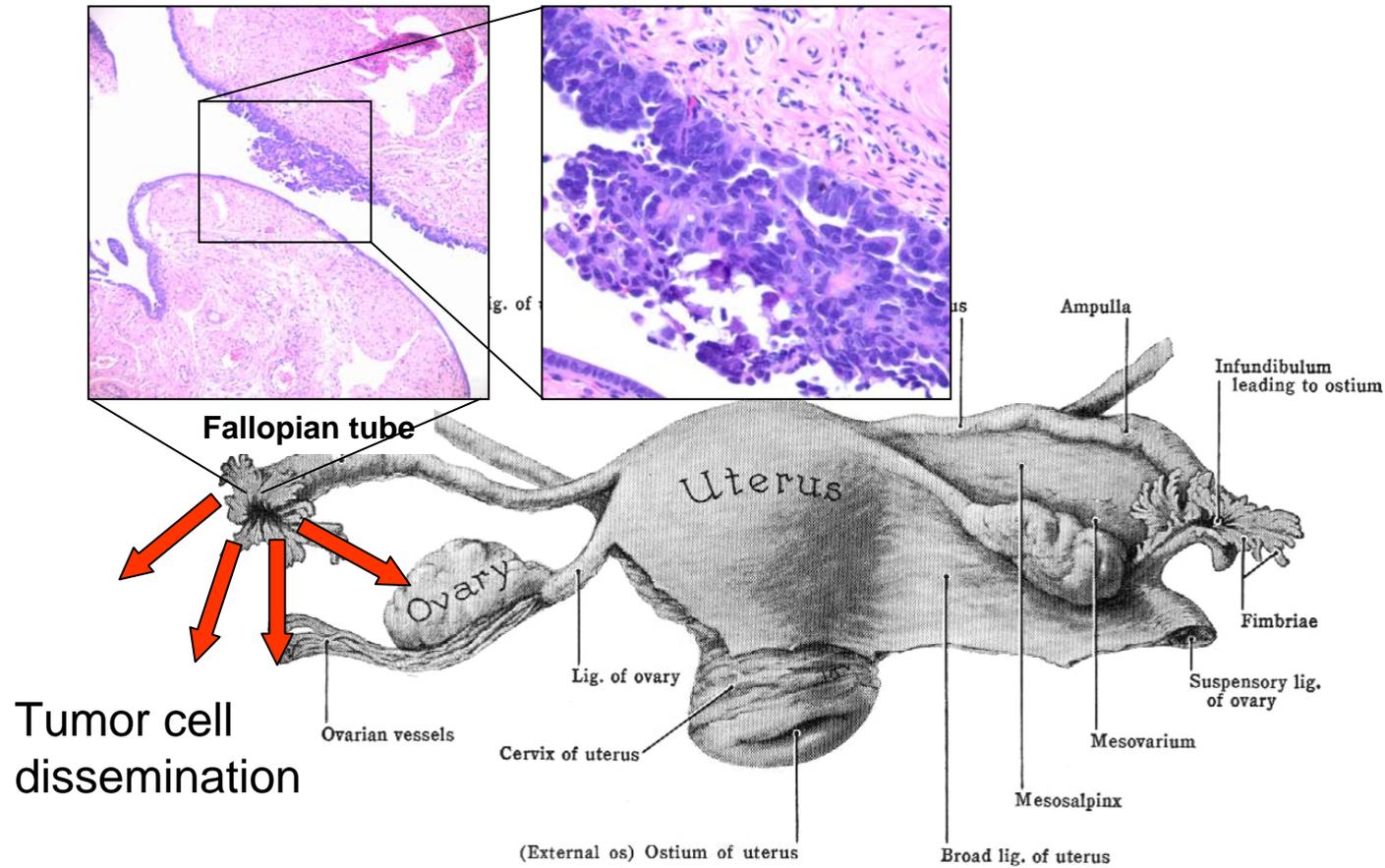


b

The fact



New hypothesis- fallopian tube origin of “ovarian” cancer



Review question set

1. Which of the following cell type does NOT produce hormone(s):

- A. Theca cells.
- B. Corpus luteal cells.
- C. Syncytiotrophoblast.
- D. Ovarian surface epithelium.
- E. Ovarian stromal cells.

2. Which of the following statement is NOT correct regarding human endometrium?

- A. It is composed of glandular epithelium and underlying stromal tissues.
- B. It is the site for implantation occurs.
- C. Subnuclear vacuolization is a sign of the late menstrual cycle.
- D. Progesterone is the major hormone responsible for secretory changes in the endometrium.
- E. All of above is correct.

3. The pregnancy (except the first few weeks) is maintained and progressed by:

- A. Estrogen secreted by follicular cells in the ovary.
- B. Progesterone secreted by corpus luteum in the ovary.
- C. hCG secreted by human placenta.
- D. LH secreted by pituitary glands.
- E. FSH secreted by pituitary glands.

4. Which of following statements is correct?

- A. Fallopian tube connects uterus and ovary in a continuum.
- B. Ovary is the most common site for ectopic pregnancy.
- C. Endometrial gland is the primary source of mucin in vaginal wall.
- D. Corpus luteum is no longer present in postmenopausal ovaries.
- E. Vulva is not considered as skin because it does not contain skin appendages.

5. Which of the following structure is NOT derived from Mullerian duct?

- A. Reti ovarii.
- B. Fallopian tube.
- C. Endometrium.
- D. Endocervix.
- E. Upper third of vagina.

6. Which of following condition is most likely associated with a preterm labor?

- A. Fallopian tube atresia.
- B. Cervical incompetence.
- C. Removal of ovary in late pregnancy.
- D. Vaginal wall relaxation.
- E. HPV infection in vulva.

7. Which of the following statement is correct regarding HLA-G molecule?

- A. The secreted form is produced by the ovary.
- B. It is essential to stimulate the placental growth during pregnancy.
- C. It participates in immune suppression in the placenta.
- D. It belongs to MHC class I molecules.
- E. None of above.

8. Which of the following statement is NOT correct regarding the development of female genital organs?

- A. Ovaries developed from urogenital ridge.
- B. Rete ovarii is the embryonic remnant of mesonephric duct.
- C. Upper third and lower third of vagina are derived from different embryonic structures.
- D. Wolffian ducts fused to form the uterine body.
- E. Vulva developed from the skin not the Mullerian duct.