HISTOLOGY

Reproductive Block – 432 Histology Team

Lecture 2: Female Reproductive System

Done by:
Bayan AL-Mugheerah &
Sahar Alharthi

Reviewed by:
Nada Alouda

Color Guide:

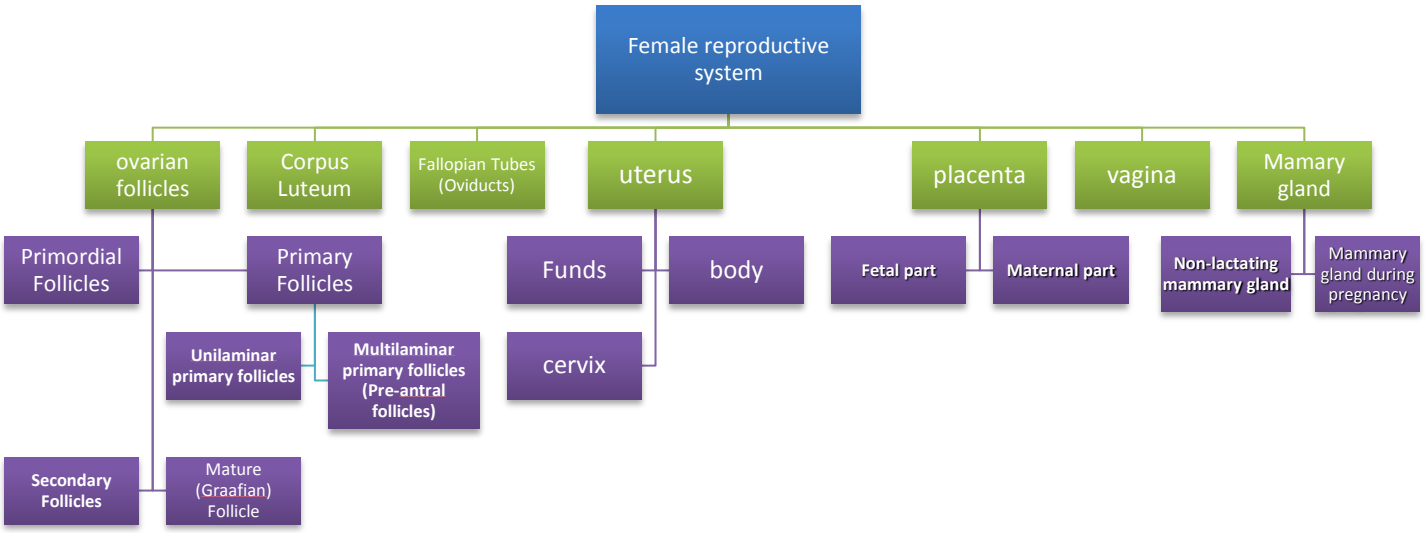
- **Black: Slides.**
- **Red: Important.**
- **Green: Doctor's notes (Female).**
- **Blue: Doctor's notes (Male).**
- **Orange: Explanation.**

Objectives

At the end of this lecture, you should describe the microscopic structure and the function of:

- Understand and identify the stages of ovarian follicular growth as well as the changes that occur in the follicular wall during pregnancy.
- Identify the regional variations in the structure of the oviduct (Fallopian tube).
- Describe the structure and the changes that occur in the ovary, and uterus during the menstrual cycle.
- Describe the histological structure of vagina and placenta.
- Describe the changes that occur in the mammary glands before and after pregnancy.

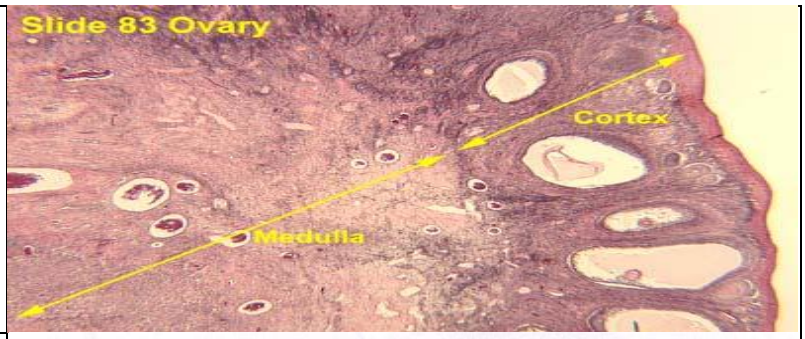
Mind Map



Adult Ovary

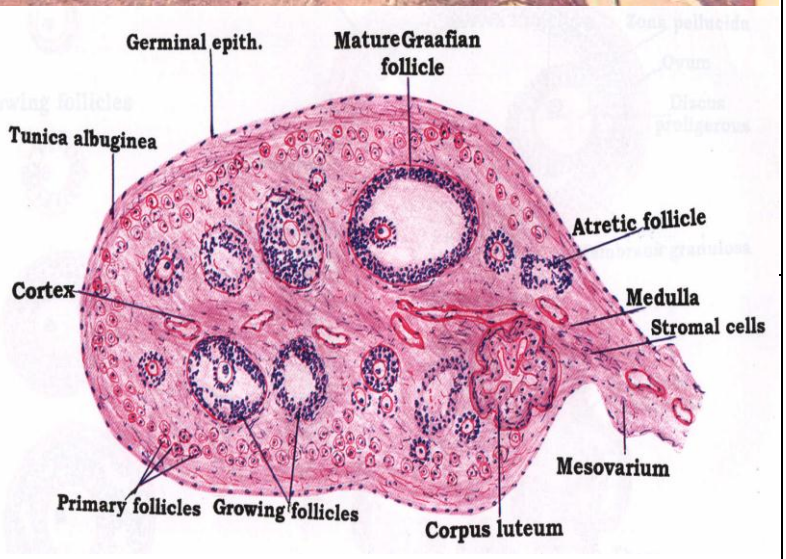
ADULT OVARY

1. **Germinal epithelium:** outer layer of flat cells covering the outer surface.
2. **Tunica albuginea:** dense C.T layer beneath the germinal epithelium.
3. **Outer cortex:** contains ovarian follicles and interstitial stromal cells.
4. **Inner medulla:** highly vascular loose C.T.



NOTES:

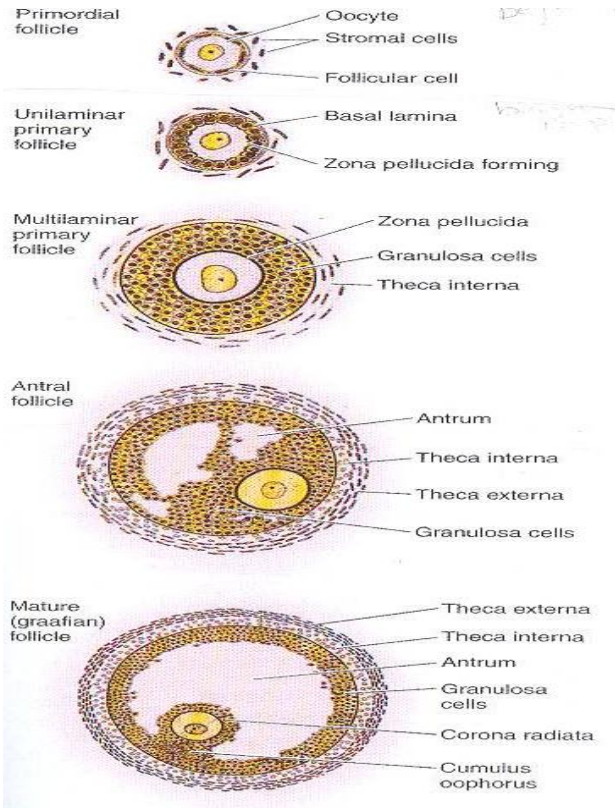
Ovaries are concerned with the production of ova (exocrine function) and secretion of female sex hormones (endocrine function).

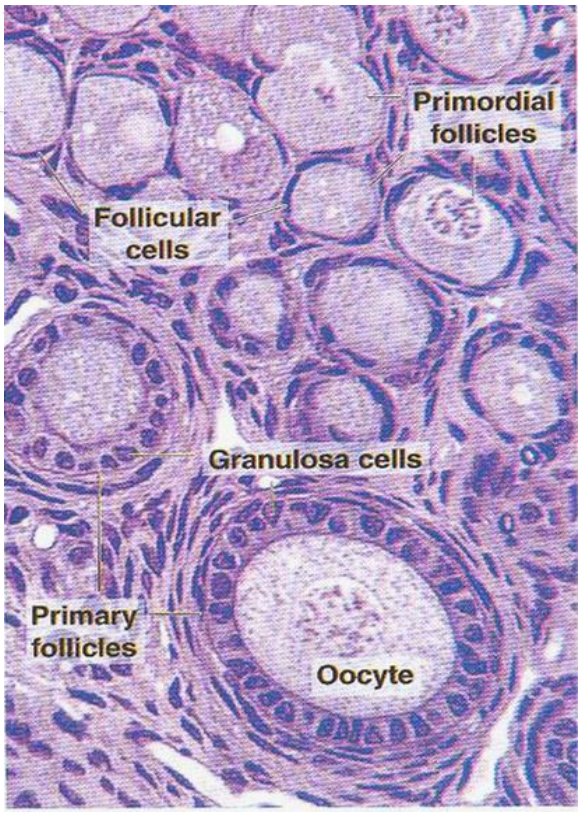


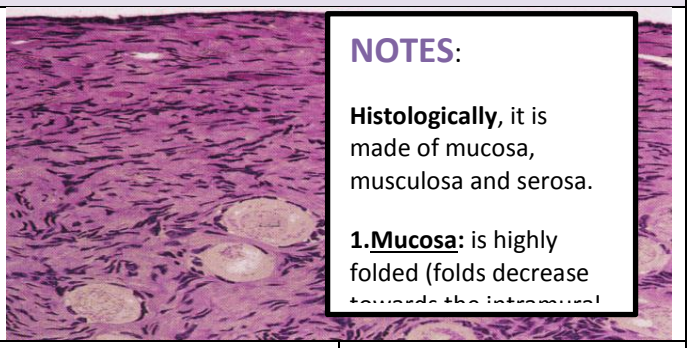
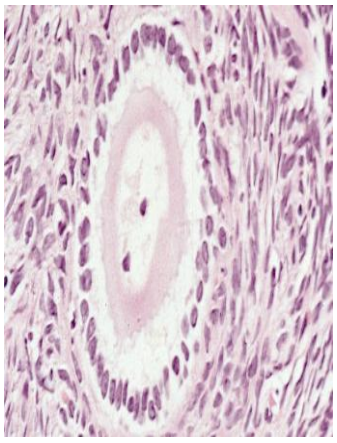
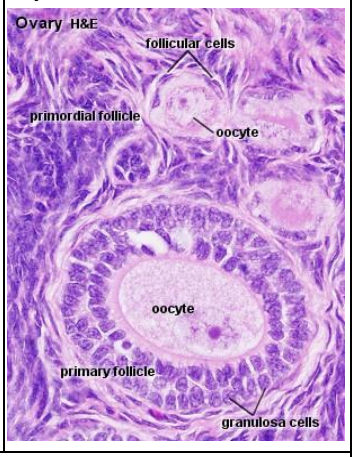
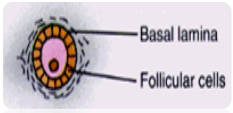
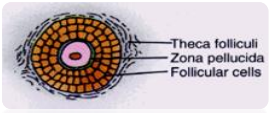
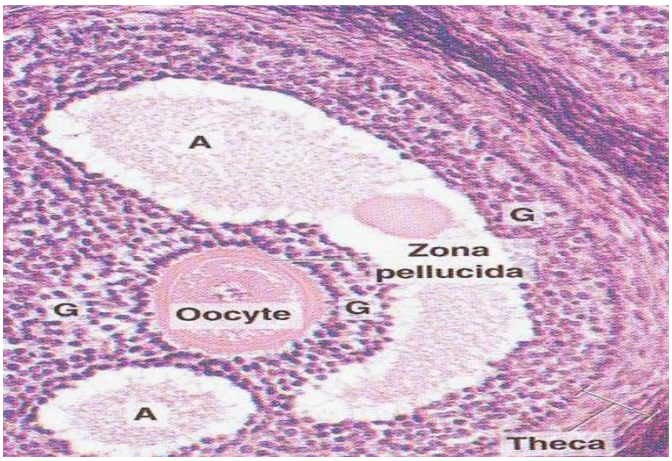
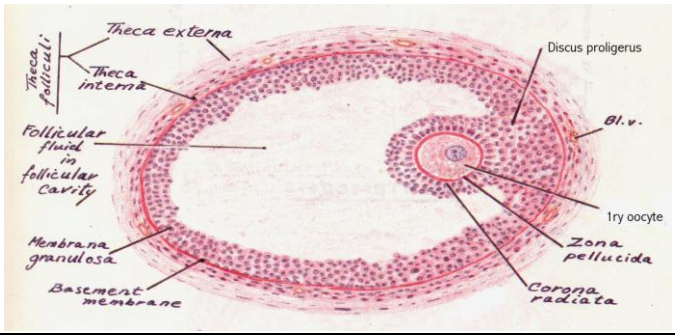
Ovarian Follicles:

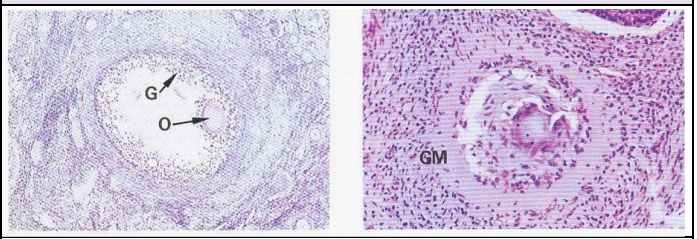
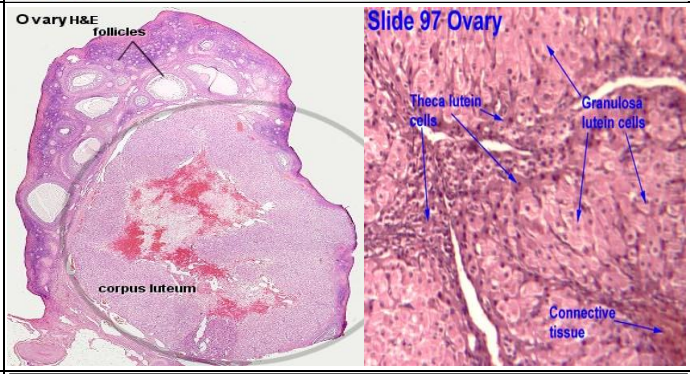
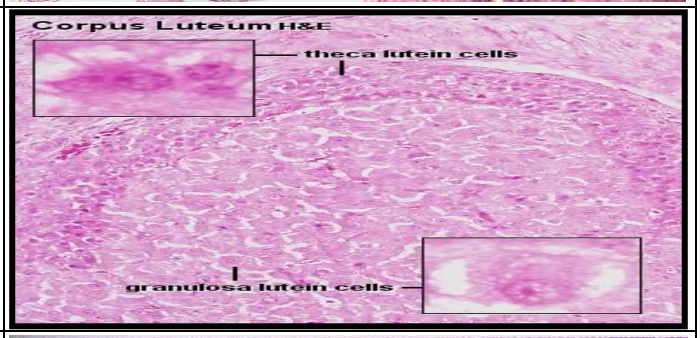
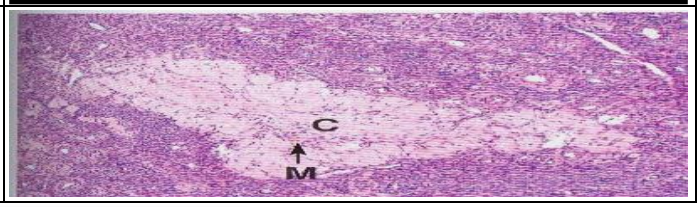
1. **PRIMORDIAL follicles.**
2. **PRIMARY follicles:**
   a. Unilaminar
   b. Multilaminar
3. **SECONDARY (ANTRAL) follicles.**
4. **MATURE Graafian follicles.**
5. **ATRETIC follicles.**

Follicular growth

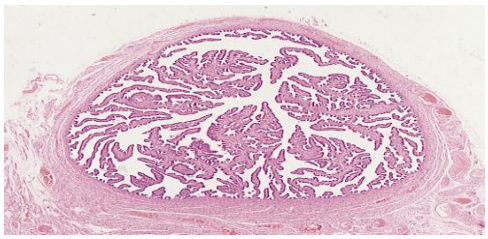
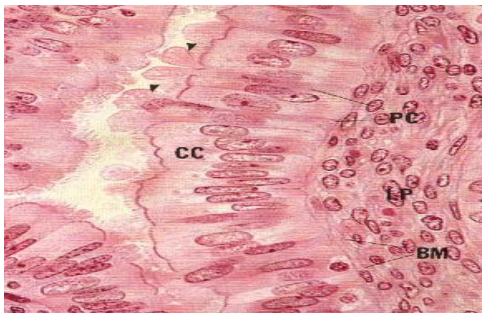




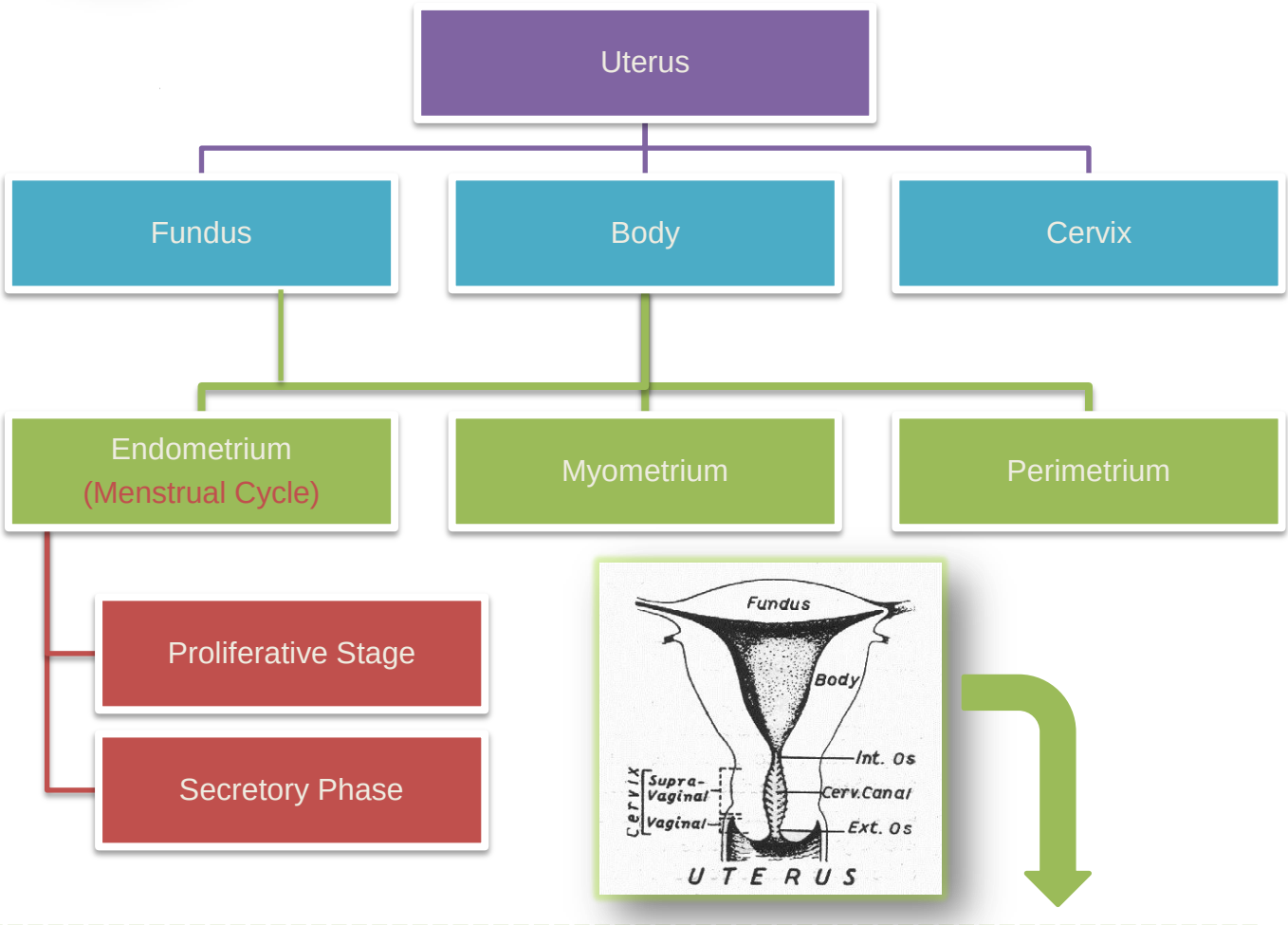
<table>
<tr><th>Ovarian Follicles</th><th>General Features</th><th>L\M</th></tr>
<tr><td>1- Primordial Follicles</td><td>• Earliest and most numerous stage.
• Located superficially under the tunica albuginea.
• Each follicle is formed of a primary oocyte (25 µm in diameter), surrounded by a single layer of flat follicular cells.</td><td colspan="2"> 
NOTES:
Histologically, it is made of mucosa, musculosa and serosa.
1.Mucosa: is highly folded (folds decrease towards the intramural</td></tr>
<tr><td rowspan="3">2- Primary Follicles</td><td colspan="2">Similar to primordial follicles but develop from the primordial follicles, at puberty under the effect of FSH.</td><td>a)
  </td><td>b)
  </td></tr>
<tr><td>a) Unilaminar:
• The primary oocyte is larger (40 µm)
• The follicular cells are cuboidal.
  </td><td>b) Multilaminar (Pre-antral follicles):
• Oocyte larger.
• Corona radiate.
• Granulosa cells.
• Zona pellucida.
• Theca folliculi.
  </td><td colspan="2"></td></tr>
<tr><td colspan="4">• The follicular cells enlarge (50 µm) and become columnar in shape (corona radiata), then they proliferate, forming several layers of polyhedral cells (granulosa cells).
• The granulosa cells are separated from the primary oocyte by a layer of glycoprotein (zona pellucida), formed by secretions from the granulosa cells and the oocyte.
• The C.T. stroma around the follicle forms a capsule (theca folliculi), which surrounds the follicle.</td></tr>
<tr><td>3- Secondary Follicles (Antrum follicles)</td><td colspan="2">Between the stratified granulosa cells, there are large lacunae that coalesce to form the follicular antrum.
The stromal cells surrounding the follicle have differentiated to form an inner layer (theca interna) of cells that secrete steroid precursors and an outer layer (theca externa) composed of concentrically arranged stromal cells that provide support for the developing follicle.
Note: The difference between multilaminar primary follicle & the secondary follicle is the presence of fluid.</td><td colspan="2">  </td></tr>
<tr><td rowspan="2">4- Mature (Graafian) Follicle</td><td colspan="2">• Large, thin walled.
• Wide follicular antrum.
• Large oocyte.
• Zona pellucida.
• Corona radiate.
• Cumulus oophorus (is connecting the ovum to the wall of the follicle).
• Zona granulosa & basement membrane.
• Theca folliculi.</td><td colspan="2">  </td></tr>
<tr><td colspan="4">The wall of the Graafian follicle is made of:
1.Zona granulosa. 2.Basement membrane. 3.Theca folliculi: It is formed of outer dense theca externa and inner loose vascular theca interna. Cells of theca interna secrete oestrogen.</td></tr>
</table>

Ovarian Follicles	General Features	L\M
5- Atretic Follicles	During growth of the ovarian follicles, many of them do not reach maturation and they degenerate, and finally replaced completely by fibrous tissue and are called <u>atretic follicles</u> or corpora atretica.	
Corpus Luteum	• Zona granulosa → granulosa lutein cells. • Theca interna → theca lutein cells. • Bleeding may occur → corpus haemorrhagicum. • Fertilization → corpus luteum of pregnancy. • No fertilization → corpus luteum of menstruation. • At the end → corpus albicans.	
	Corpus luteum *contains:* **1- Granulosa lutein cells:** Secrete progesterone+ small amount of estrogen **2- Theca lutein (interna):** Secrete estrogen. **<u>There are 2 types of corpus luteum (CL):</u>** 1- CL of menstruation lasts 14 day. 2- CL of pregnancy lasts 4 months.	
Corpus Albicans	Is formed due to involution of corpus luteum (degenerated corpus luteum) Secretory cells of corpus luteum undergoes degenerations and are phagocytosed by macrophages.	

Fallopian Tubes

FALLOPIAN TUBES (OVIDUCTS)		
Mucosa	– Highly folded. – **Epithelium:** Simple Columnar Epith. partially ciliated. – **Corium of C.T.** ▪ **<u>Epithelium lining of the mucosa:</u>** **1- Ciliated cells:** ○Non-secretory. ○Cilia beat toward uterus. **2- Non-ciliated cells:** ○Thinner, also called peg cells (secretory cells). ○Their apices contain nutritive material to nourish gametes.	 
Musculosa	• Inner circular. • Outer longitudinal.	
Serosa	Loose C.T. covered by mesothelium.	

Uterus



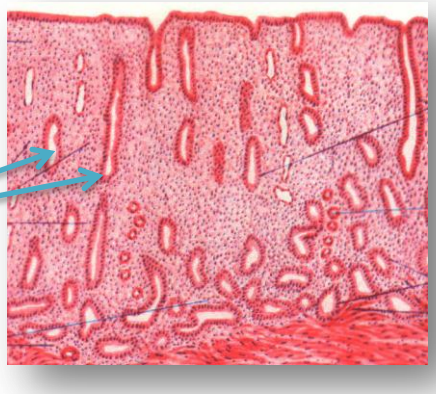
- The uterus is thick-walled muscular organ.
- It has an inverted pear shape.
- The flattened triangular cavity of the body is continuous above with that of each of the fallopian tubes and below it communicates with the canal of the cervix (cervical canal) through the internal os.
- And is anatomically divided into:
  - Body: Upper 2/3
  - Cervix: Lower 1/3
    - The cervix is divided into a vaginal and a supravaginal portion.
    - A Characteristic feature of the cervix is that it's protruding into the vagina, and is attached to the wall of the vagina.
    - **The epithelium of protruding part of cervix is similar to that of the vagina, while the rest of the cervix epithelium is similar to that of the fallopian tube.**
  - Fundus: The rounded dome-shaped top of the body.
- <u>The fundus and the body are histologically the same, and are composed of:</u>
  - **Endometrium (mucosa).**
  - **Myometrium (Musculosa).**
  - **Perimetrium (Serosa or Adventitia).**

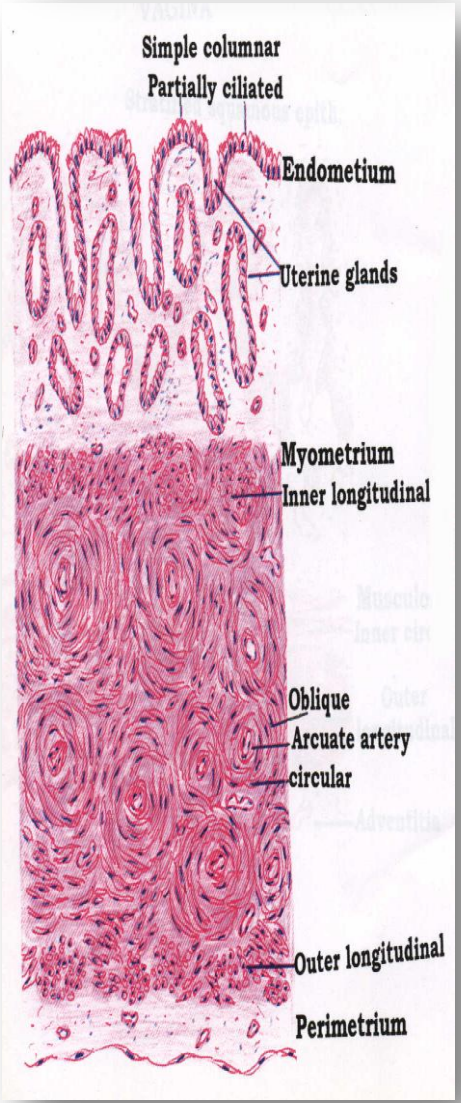
Fundus & Body

Fundus & Body

Endometrium (Mucosa)

- Endometrium is formed of:
  - **Epithelium:** simple columnar partially ciliated (similar to the fallopian tube).
  - **Corium of CT** (endometrial stroma, thicker than that of the fallopian as it's occupied with glands).
    - **Endometrial glands**: simple tubular.
    - **Stromal cells**
      - The stromal cells are stellate-shaped.
      - The uterine phase of placenta originates from it.
      - "Decidual or Stromal cells" secrete hormones and keep the enlarged cropus luteum from atrophy during pregnancy.
    - Blood vessels.
    - Leucocytes.
    - Reticular fibers.





Myometrium (Musculosa)

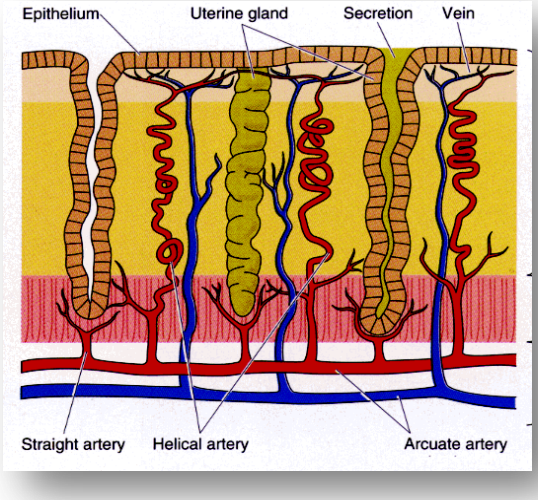
- Myometrium forms the main thickness of the wall and consists of 3 ill-defined smooth muscle layers:
  - **Stratum Submucosum:** Inner longitudinal
  - **Stratum Vasculare:**
    - Circular smooth muscle fibers in figure of 8 arrangement around large blood vessels
    - Its contraction helps to minimize the hemorrhage. It also happens after labor.
  - **Stratum Supravasculare:** Outer longitudinal

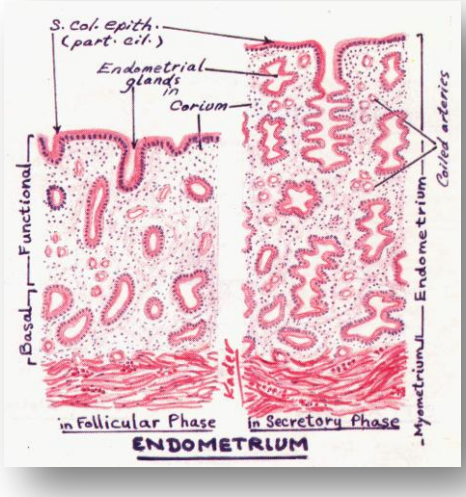
Perimetrium (Serosa or Adventitia)

- Since we know that the uterus is not completely covered by serosa nor with adventitia, but rather covered with both according to the site of coverage. Then the part that is covered with peritoneum - and we know it by seeing the mesothelium - is the serosa, and the part that is covered with urinary bladder is the adventitia.

Endometrium & Menstrual Cycle

- The superficial layer of the **endometrium** is called the functional zone, as it **undergoes *cyclic changes*** during the menstrual cycle. The deeper layer is called the basal zone and it remains ***unchanged*** during the menstrual cycle, and from this layer the superficial zone regenerates after being shed during menstruation.
- Endometrium is supplied by 2 types of arteries derived from vessels in the myometrium:
  - **Coiled Arteries:**
    - Extend into the functional zone "stratum functionalis" (superficial layer).
    - Cyclic Changes: They undergo marked changes during different stages of the menstrual cycle (vasoconstriction followed by sudden vasodilatation result in sloughing of the functional zone at menstruation).
  - **Straight Arteries:**
    - Terminate in basal zone "stratum basalis" (basal layer).
    - No cyclic changes; that's why the basal zone is preserved during menstruation.
    - **Application from life:** in abortion they do D&C (dilation & curettage) procedure, curettage should be restricted to the superficial layer; and if by mistake the basal layer was curettage; then this might mostly cause infertility.
- Endometrium; menstrual cycle:
  - **Proliferative Stage of The Uterus:**
    - Under the effect of estrogen coming from follicles.
    - Glands have proliferated and cover the surface.
    - The spiral arteries are elongated and convoluted, and extend from the basal layer into the functional layer.
  - **Secretory Phase of The Uterus:**
    - Under the effect of progesterone and estrogen of corpus luteum.
    - Glands of the secretory phase endometrium appear convoluted.
    - Toward the end of this phase, apical tissues become ischemic and glands take on a characteristic "saw tooth" appearance.
    - The endometrium reaches its maximal thickness during this period.
    - And spiral arteries continue to grow and extend into the superficial regions of the functional layer.
    - There is also considerable leukocyte infiltration in the stroma.





Uterine Cervix

- Mucosal Lining
  - **Epithelium:**
    - **Endocervix:** Simple columnar mucus-secreting in the cervical canal.
    - **Ectocervix:** stratified squamous epithelium non-keratinized at the external os.
  - **Corium:**
    - C.T containing branched tubulo-alveolar glands (cervical glands) but doesn't have spiral arteries.

❖ The cervix produces the cervical mucus:

1- **At ovulation**, the cervical mucus is **more watery**, so the spermatozoa can penetrate, to enter the uterine cavity.

2- **During pregnancy**, the cervical mucus is **thick and viscous**, preventing the entry of spermatozoa and microorganisms into the uterine cavity.

❖ The function of the cervix is:

1- To admit spermatozoa to the genital tract at the time when fertilization is possible.

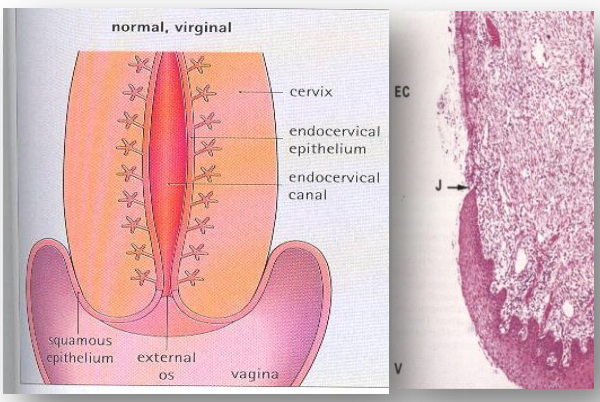
2- In pregnancy, to protect the genital tract from bacterial invasion.

3- In addition, the cervix is capable of great softening and dilatation during labour.

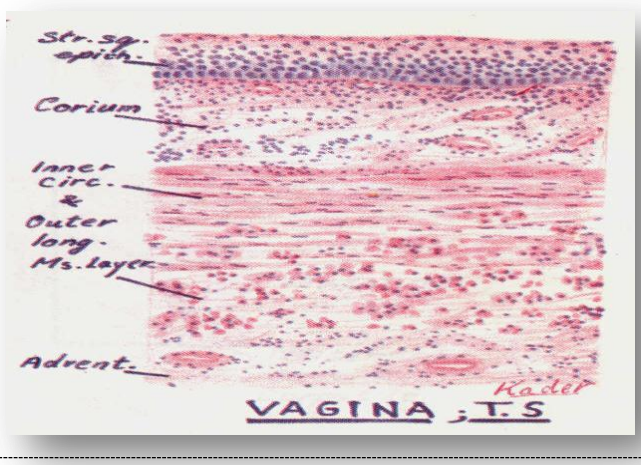
- Wall of The Cervix
  - Dense fibrous tissue with elastic fibers and very few smooth muscle fibers.

Vagina

- The vagina has a flattened lumen and its wall consists of three layers:
  - **Mucosa**
    - Shows transverse folds and is made of:
    - Epithelium: stratified squamous epithelium non-keratinized, rich in **glycogen** (it acts as nutrient to the sperms & is converted to lactic acid so it creates an acidic medium, which inhibits the growth of harmful microorganisms).
      - ❖ Corium: of C.T, very rich in blood vessels, elastic fibers & leucocytes.
  - **Musculosa**
    1- Inner circular layer of smooth muscle fibers
    2- Outer longitudinal layer of smooth muscle fibers
  - **Adventitia**
    - Formed of loose C.T. rich in elastic fibers.
- Notes to remember about the vagina:
  - The vagina is a fibromuscular tube capable of great distension (elastic fibers).
  - It contains **no glands** and its surface is lubricated by **the mucous secreted by the cervical glands**.

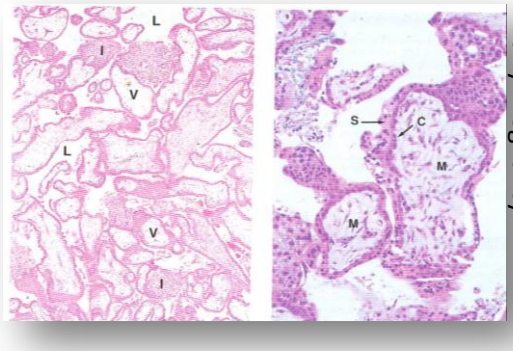


Uterine Cervix

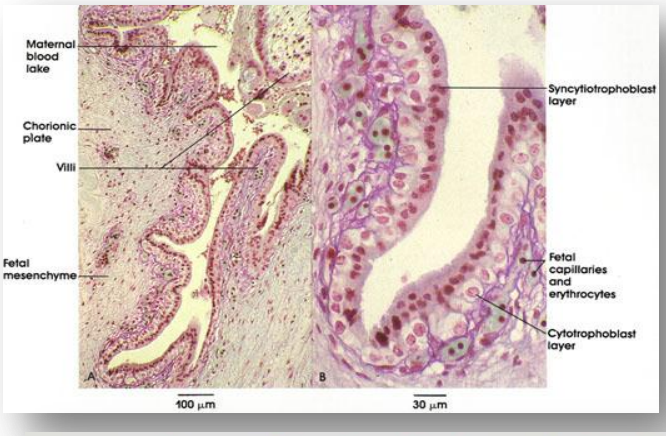


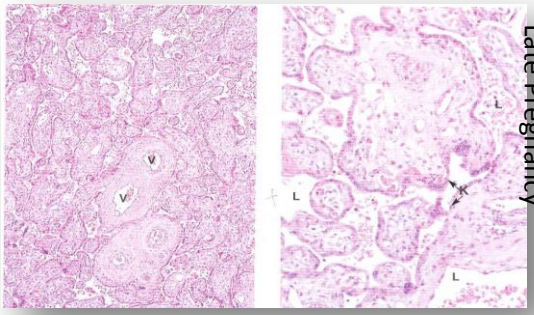
Placenta

- Formed between the mother (uterus) and the fetus.
  1. **Fetal Part:**
     - **Chorionic plate & chorionic villi.**
  2. **Maternal Part:**
     - **Decidua basalis.**
     - During pregnancy, the blood in the endometrium will not be restricted to the blood vessels, but rather exposed or free in the decidua. (Like in the spleen, the blood will be free). So the villi will be surrounded with blood.
- Chorionic (مشيمي) villus is formed of:
  - Central core of mesenchymal =not differentiated; embryonic) C.T.
  - Fetal blood capillaries. (Remember: NO maternal blood capillaries as the maternal blood is free).
  - Trophoblasts:
    1- **Syncytiotrophoblas:** superficial & darkly stained.
    2- **Cytotrophoblasts:** disappear in late pregnancy.
- Placental Barrier: it is the barrier between maternal blood in the intervillous spaces and foetal blood in the fetal blood capillaries in the chorionic villi. It consists of:
  1- The trophoblasts covering the villus.
  2- The basement membrane of the trophoblasts.
  3- The C.T. core of the villus.
  4- The basement membrane of foetal blood capillaries.
  5- The endothelium of foetal blood capillaries.



Early Pregnancy





Late Pregnancy

Mammary Glands

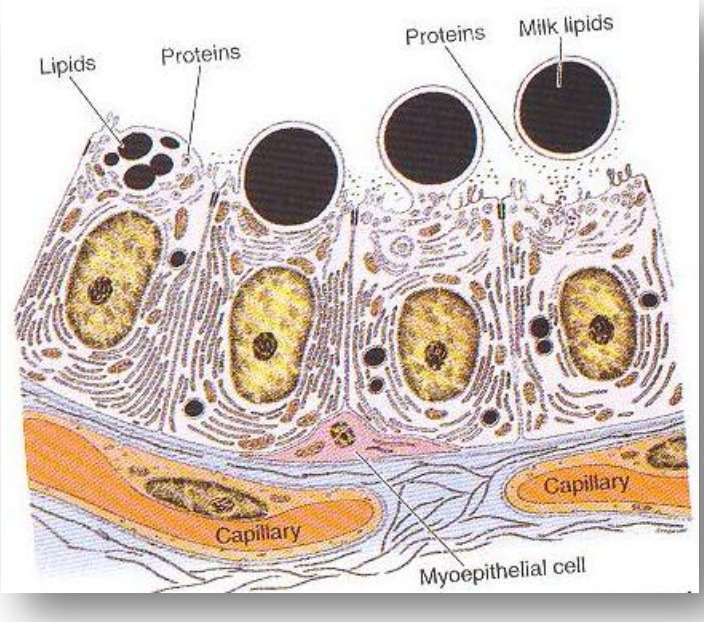
- It's considered as a modified skin gland; more specifically as a modified sweat gland covered by skin.
- Mammary Glands has 3 stages:
  - **Non-Lactating Mammary Gland (before pregnancy):**
    - Consists of few clusters of intralobular small ducts (lined with simple cuboidal epithelium) & intralobular loose C.T.
    - **The majority of the gland** is a mass of dense, fibrous C.T. (Forming the interlobar & the interlobular septa) with collections of adipose tissue.
    - **Lactiferous ducts:** are lined with stratified columnar epithelium.
    - **Lactiferous sinuses & terminal part of lactiferous ducts:** are lined with stratified squamous epithelium.
  - **Mammary Gland During Pregnancy:**
    - Each lobule will be enlarged while the inter- and intra-lobular connective tissues are decreased.
    - Terminal ends of the intralobular ducts show dilated acini (alveoli) that are lined with low columnar or cuboidal epithelium and **myoepithelium**.
    - Changes happen even if the fetus dies before labour.
  - **Lactating Mammary Gland:**
    - Marked reduction of interlobular tissue.
    - Marked reduction of interlobular C.T.
    - Markedly distended acini (alveoli) **with milk**.
    - Acini are lined with flat epithelium.
    - **NB.** Suckling stimulates prolactin & oxytocin hormones secretion.
- Mechanism of Milk Secretion:
  - **Merocrine** (Exocrine): For Protein.
  - **Apocrine** (coming from the apex of cell membrane surrounding the lipid droplet): For Lipid.

Mammary Glands:

Before Pregnancy
- **Mainly adipose tissue and ducts.**
- **Immature Gland.**

During Pregnancy
- **Budding of alveoli.**
- **Decreasing of adipose tissue.**

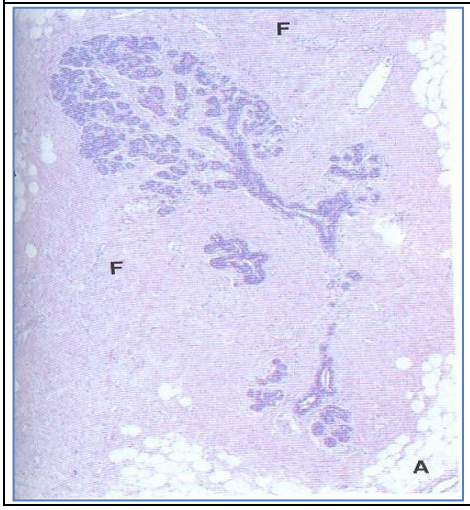
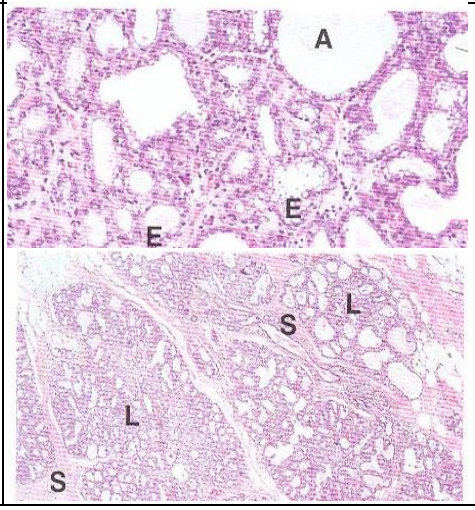
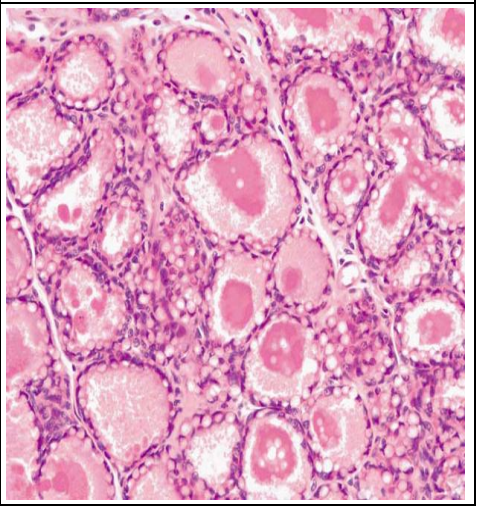
During Lactation
- **Alveoli engorged with milk.**
- **Markedly decrease of adipose tissue.**



Summary of female duct system

Layers		Oviduct	Uterus (body & fundus)	Uterine cervix		Vagina
Mucosa	**Epithelium**	Simple columnar partially ciliated. - Secretory (peg) cells).	Simple columnar partially ciliated.	**Endocervix:** Simple columnar mucus-secreting cells.	**Ectocervix:** Str. Squamous non-keratinized.	Str. Squamous non-keratinized.
	Corium	Thin layer of C.T.	**Modified epith:** - Endometrial glands, - stromal cells, - blood vessels…	C.T containing branched tubulo-alveolar glands (cervical glands)		Very rich in blood vessels, elastic fibers & leucocytes.
Musculosa		- Inner circular. - Outer longitudinal.	- Inner & outer longitudinal. - Middle circular.	<u>Wall of The Cervix</u> Dense fibrous tissue with elastic fibers and few smooth muscle fibers.		- Inner circular. - Outer longitudinal.
Serosa\Adventitia		Serosa.	Serosa\Adventitia			Adventitia.

Summary of mammary gland

Non-lactating mammary gland	Mammary gland during pregnancy	Lactating mammary gland
1- Consists of few clusters of intralobular small ducts (lined with simple cuboidal epithelium) & intralobular loose C.T. 2- **The majority of the gland** is a mass of dense, fibrous C.T. and adipose tissue. 3- **Lactiferous ducts:** are lined with stratified columnar epithelium. 4- **Lactiferous sinuses & terminal part of lactiferous ducts:** are lined with str. squamous epith.	1- Each lobule will be enlarged while the inter- and intra-lobular connective tissues are **decreased**. 2- Terminal ends of the intralobular ducts show dilated acini (alveoli) that are lined with low columnar or cuboidal epithelium and **myoepithelium**.	1- **Marked reduction** of interlobular tissue. 2- **Marked reduction** of interlobular C.T. 3- Markedly distended acini (alveoli) **with milk**. 4- Acini are lined with flat epithelium. 5- **NB.** Suckling stimulates prolactin & oxytocin hormones secretion.
		

Questions

Q1: Which one of the following is located superficial and under the tunica albuginea?

A. Primary Follicles
B. Mature (Graafian) Follicle
C. Primordial Follicles

Q2: Progesterone secrete from corpus luteum by?

A. Theca lutein cells
B. Granulosa lutein cells
C. Non

Q3: The ciliated cell that lining the epithelium of mucosa is?

A. Secretory cell
B. Cuboidal cell
C. Non- secretory

Q4: Which of the following layers of uterus undergoes cyclic changes?

A. Endometrium
B. Myometrium
C. Perimetrium

Q5: What is the lining epithelium of the endometrium?

A. Simple cuboidal epithelium
B. Non-Keratinized squamous epithelium
C. Simple columnar partially ciliated epithelium

Answers

1	2	3	4	5
C	B	C	A	C

If you have any questions or suggestions please do not hesitate to contact us on:

432histologyteam@gmail.com

Histology Team Leaders:

Nada Alouda **Faisal Alshuwair**

Best of luck!