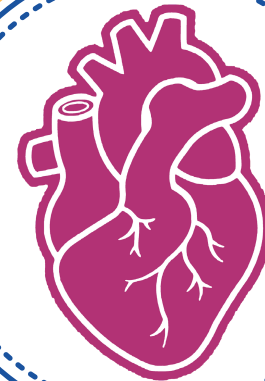


UROGENITAL SYSTEM

#10
PART 2

ANATOMY



PULSE TEAM



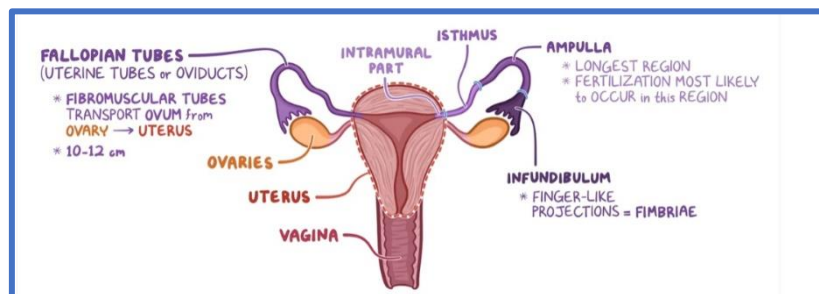
**So, after we talked about the ovarian cycle that includes 2 phases, one before the ovulation (follicular growth phase) & one after the ovulation (luteal phase), it's the time to talk about the uterine tube where the fertilization occurs within 24 hours.

**Up to the next part, the uterine tube.

The uterine tube

General information

- × The paired uterine tubes, or oviducts, supported by ligaments and mesenteries, which allow considerable mobility, each measure about 10-12 cm in length, and here the fertilization occurs.
- × Each opens into the uterus from the intramural part while from the infundibulum it opens to the peritoneal cavity near the ovary.
- × The tube is divided into regions in the following sequence:
 1. The infundibulum, a funnel-shaped opening fringed with finger like extensions called fimbriae next to the ovary.
 2. The ampulla, the longest and expanded region where fertilization normally occurs.
 3. The isthmus, a narrower portion nearer the uterus.
 4. The uterine or intramural part, which passes through the wall of the uterus and opens into the interior of this organ.



Histology

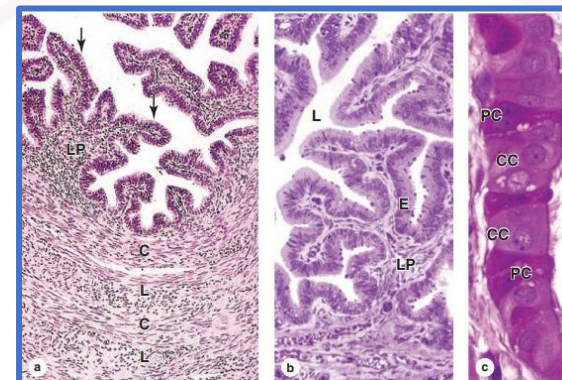
The wall of the oviduct consists of: (inside to outside)

1. A folded mucosa.
2. A thick, well-defined muscularis with interwoven **circular (or spiral) and longitudinal layers** of smooth muscle.
3. A thin **serosa covered by visceral peritoneum** with mesothelium.

Mucosa in detail

- × Along its entire length, the mucosa is lined by **simple columnar epithelium** on a lamina propria of loose connective tissue.
- × The epithelium contains two interspersed, functionally important types:
 - A. **Ciliated** cells in which ciliary movements sweep fluid to the uterus.
 - B. **Secretory peg** cells, non-ciliated and often darker staining, often with an apical bulge into the lumen, which **secrete glycoproteins of a nutritive mucus film that covers the epithelium.**

The numerous branching, **longitudinal folds of the mucosa are most prominent in the ampulla**, which in cross section resembles a labyrinth, these **mucosal folds become smaller in the regions closer to the uterus and are absent in the intramural portion of the tube.**



1st picture

**LP: lamina propria
**C: circular
**L: longitudinal

2nd picture

**L: lumen
**E: epithelium
**LP: lamina propria

3rd picture

**PC: Peg cells (secretory)
**CC: Ciliated cells



How did the natural histology benefit the female processes?

- × During the **follicular growth phase** of the ovarian cycle, the cilia elongate and both cell types (ciliated & peg) undergo **hypertrophy** triggered primarily by estrogens, so at the time of ovulation, mucosal hypertrophy and increased blood flow have enlarged & reached their peak and moved the uterine tubes.
- × During the **late luteal phase** both undergo **atrophy** with loss of cilia.
- × The **fringed infundibulum lies very close to the ovary and the fimbriae partially surround that organ**. This Favors the transport of the ovulated secondary oocyte into the tube, and thus promoted by sweeping muscular contractions of the fimbriae and ciliary activity, the oocyte enters the infundibulum and moves to the ampulla.

****The secretion covering the mucosa has nutritive and protective functions for both the oocyte and the sperm, including **capacitation factors** that activate sperm and make those cells able to fertilize an oocyte.**

.....
****And now, because we already study the ovary and its cycle, its worth knowing about the uterus and its own cycle which happens at the same time in response to the ovarian cycle which complete the menstrual cycle.**

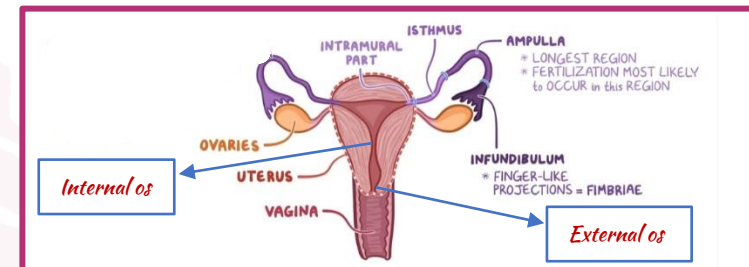
****Up to one of the most important parts, the uterus.**

The uterus

General information

- × The uterus is a pear-shaped organ with thick, muscular walls.
- × Its largest part, the body, is entered by the left and right uterine tubes and the curved, superior area between the tubes is called the fundus, and after the body the uterus narrows in the isthmus and ends in a lower cylindrical structure called the cervix.

- × The lumen of the cervix, the cervical canal which has 2 ends, has constricted openings at each end:
 - A. The internal os opens to the main uterine lumen.
 - B. The external os to the vagina.



Histology (pictures next page)

Supported by the set of ligaments and mesenteries also associated with the ovaries and uterine tubes, the uterine wall has three major layers: (inside to outside)

1. A mucosa, the **endometrium**, lined by simple columnar epithelium.
2. A thick tunic of highly vascularized smooth muscle, the **myometrium**.
3. An outer connective tissue layer, the **perimetrium**, continuous with the ligaments, which is adventitial (no coverings) in some areas, but largely a serosa covered by mesothelium.

****These three layers are continuous with their counterparts in the uterine tubes. The thickness and structure of the endometrium is influenced cyclically by the shifting levels of ovarian hormones even more than the mucosa of the uterine tubes.**

Mucosa (Endometrium) in detail

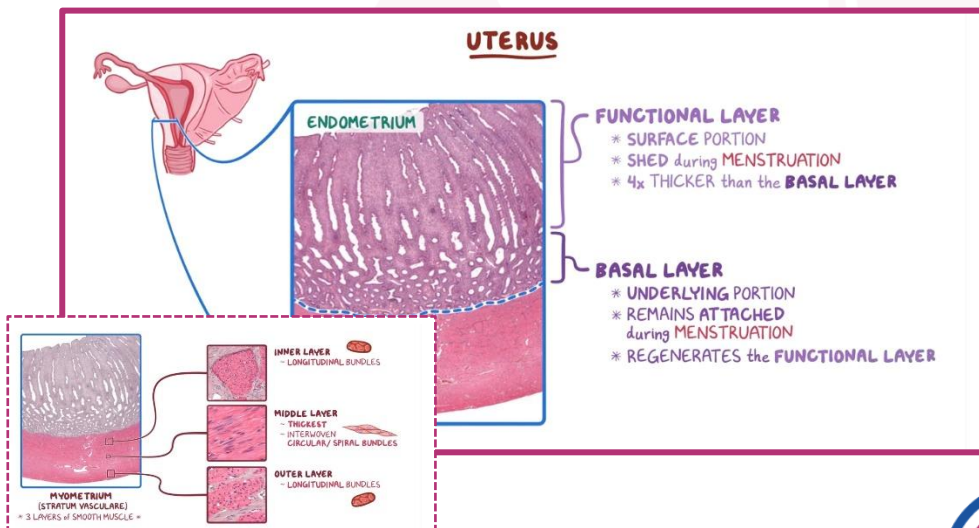
- × The surface epithelial lining is **simple columnar** and has **both ciliated and secretory cells** (like the uterine tube), and the latter line the numerous tubular uterine glands, which penetrate the full thickness of the endometrium.



- × The endometrium has two concentric zones:
 - The basal layer** which gives rise to a new functional layer, it is adjacent to the myometrium has a more highly cellular lamina propria and contains the deep basal ends of the uterine glands.
 - The superficial functional layer** has a spongier lamina propria, richer in ground substance, and includes most of the length of the glands, as well as the surface epithelium.
- × The lamina propria or stroma of the endometrium contains primarily nonbundled type III collagen fibers with abundant fibroblasts and ground substance.

Muscles (Myometrium) in detail

- × The thickest tunic of the uterus, shows bundles of smooth muscle (3 layers) fibers separated by connective tissue containing venous plexuses and lymphatics.
- × The smooth muscle forms interwoven layers (like the uterine tube), with fibers of the inner and outer layers disposed generally parallel to the long axis of the organ (inner & outer longitudinal with middle circular).



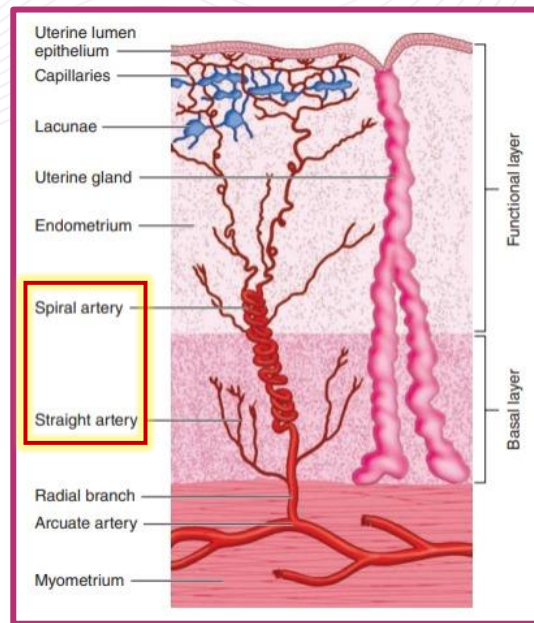
How did the natural histology benefit the female processes?

- × Cause this is the place where the embryo grows:
 - During pregnancy**, the myometrium goes through a period of extensive growth involving both **hyperplasia** (increasing the number of smooth muscle cells), cell **hypertrophy**, and **increased collagen** production by the muscle cells, which **strengthens the uterine wall**.
 - This well-developed uterine myometrium **contracts** very forcefully during **parturition** to expel the infant from the uterus.
 - After pregnancy**, uterine smooth muscle cells shrink and many undergo **apoptosis**, with removal of unneeded collagen, and the uterus **returns almost to its prepreg Nancy size**.
- × What about the changes along the menstrual cycle in response to ovary?
 - **The functional layer undergoes profound changes** during the menstrual cycles, but **the basal layer remains relatively unchanged**.

***The blood vessels supplying the endometrium have special significance in the periodic sloughing of the functional layer during menses:*

- × **Arcuate** arteries in the middle layers of the myometrium send two sets of smaller arteries into the endometrium:
 - Straight** arteries, which supply only the basal layer.
 - Long, progesterone-sensitive **spiral** arteries, which **extend farther** and bring blood throughout the functional layer, they also branch with numerous arterioles supplying a rich, superficial capillary bed that includes many dilated, thin-walled vascular lacunae drained by venules.

(picture next page)



**And now let's get to the details of the response of the uterus for the ovarian cycle and talk about the uterine cycle.

The uterine cycle (completion of menstrual cycle)

- × The female reproductive system is under the influence of estrogens and progesterone, which control the growth and differentiation of epithelial cells and associated connective tissue, even before birth, maternal estrogen and progesterone influence these cells through the placenta, and after menopause, the decreased synthesis of these hormones results in a general involution of reproductive tissues.
- × You can say that from puberty until menopause, pituitary gonadotropins drive cyclic changes in ovarian hormone levels, leading to corresponding modifications in the endometrium during the menstrual cycle.

- × The average duration of the menstrual cycle is 28 days.

****It's worth noting that menstrual cycles only occur during the years when a woman has menstrual cycles, as they are a consequence of ovarian follicle changes related to oocyte production, thus, after menopause there is no cycles.**

****And now let's talk about the phases of the uterine cycle.**

Menstrual phase

- × The **first** day of the menstrual cycle, defined by the appearance of menstrual **bleeding**, involves the discharge of degenerating endometrium mixed with blood from ruptured microvasculature **from the past cycle**, because the **fertilization did not happen**, and thus, the menstrual phase marked the beginning of a new cycle.

****Menstruation typically lasts 3-4 days.**

When fertilization and embryonic implantation do not occur, the **corpus luteum regresses**, causing a **decrease in progesterone and estrogen levels**, which leads to menstruation. This involves **spasms in small spiral arteries**, prostaglandin synthesis, arterial constriction, hypoxia, cytokine release, increased vascular permeability, and leukocyte immigration. Collagenase and other matrix metalloproteinases degrade the endometrium, **leading to the shedding of the functional layer and blood-filled lacunae**. **Arterial constriction limits blood loss, but some blood emerges from venule openings.**

- × By the end of the menstrual phase, the endometrium is usually reduced to a **thin** layer, ready to begin a new proliferative phase and cycle as its cells start dividing to reconstitute the mucosa in the next phase.



Proliferative Phase

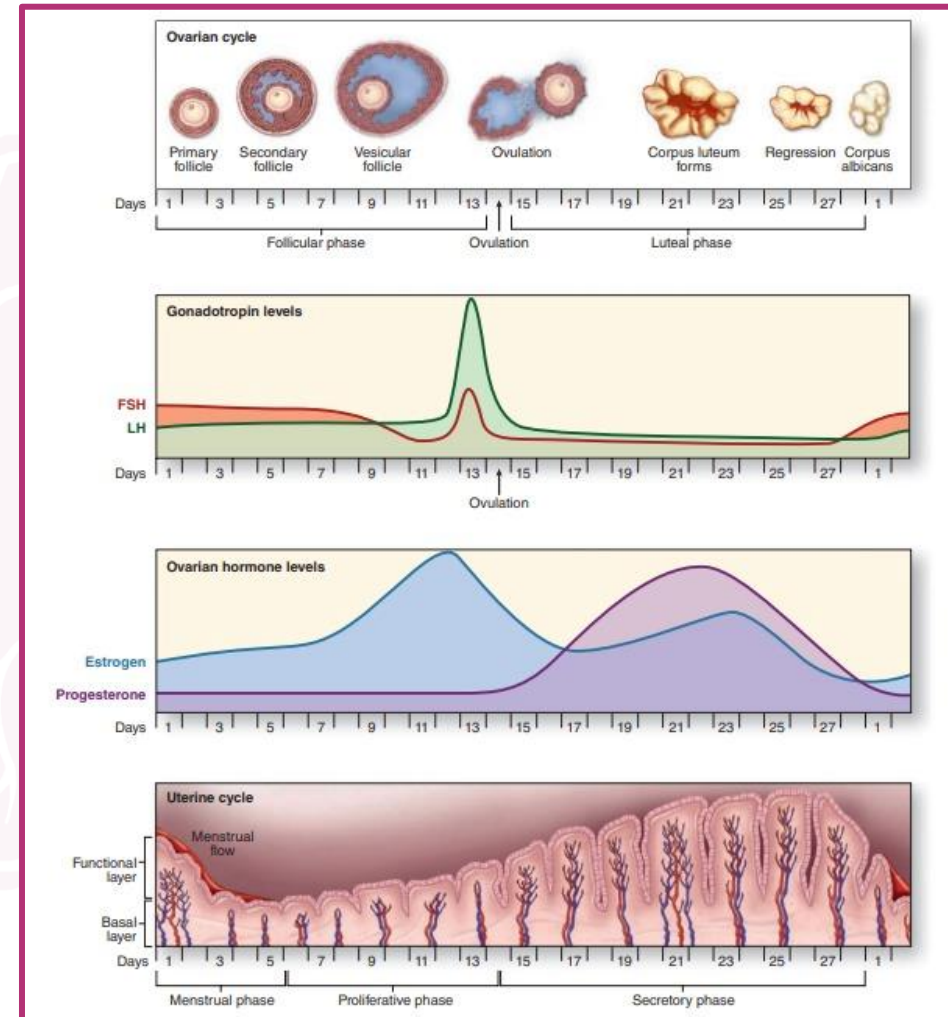
- × Following menstruation (bleeding), the uterine mucosa is relatively thin (approximately 0.5 mm), thus, the proliferative phase starts, **also known as estrogenic phase**, marked with the **rapid growth of ovarian follicles**.
- × These follicles actively secrete estrogen, which acts on the endometrium, inducing **regeneration** of the functional layer lost during menstruation, mitotic activity among epithelial cells and fibroblasts occurs, and spiral arteries lengthen.
- × By the end of the proliferative phase, **the endometrium is 2-3 mm thick**.

****Menstrual & Proliferative phases of uterine cycle happen at the same time as the follicular pre ovulation phase of the ovarian cycle.**

Secretory phase

- × The secretory or luteal phase begins **after ovulation**, driven by the **progesterone secreted by the corpus luteum**, which means that progesterone stimulates epithelial cells in uterine glands formed during the proliferative phase, leading to the **secretion and accumulation of glycogen, glandular lumen dilation, and coiling of the glands**.
 - × The **endometrium reaches its maximum thickness (5 mm)** due to secretions and stromal edema.
- **The secretory phase of the uterine cycle happens at the same time as the luteal post ovulation phase of the ovarian cycle.**
- × After that if fertilization occurs and embryo implantation is successful, the endometrial conditions are optimal for embryonic implantation and nutrition, with progesterone promoting uterine secretion and inhibiting myometrial contractions.

****If not the functional layer sheds and a new cycle begins. (negative feedback by corpus luteum)**





****And cause the uterus cervix is different from the uterus itself, it's worth mentioning it alone in its own paragraph.**

The cervix

Histology

As noted earlier the cervix is the lower, cylindrical part of the uterus, and it differs histologically from the rest of the uterus.

Mucosa in detail

- × The endocervical mucosa is a **simple columnar epithelium** on a thick lamina propria, with many large, branched, mucus-secreting glands.
- × It **lacks spiral arteries** and does not change its 2-3 mm thickness during the ovarian cycle and is not shed during menstruation. (unlike uterus)
- × The cervical region around the external os projects slightly into the upper vagina and is covered by the exocervical mucosa with nonkeratinized **stratified squamous epithelium** continuous with that of the vagina.
- × The junction between this squamous epithelium and the mucus-secreting columnar epithelium of the endocervix occurs in the transformation zone, an area just outside the external os that shifts slightly with the cyclical changes in uterine size.

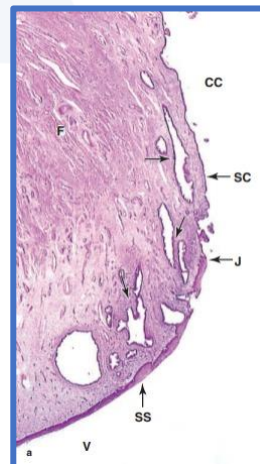
**CC: cervical canal side

**V: vaginal side

**SC: simple columnar

**SS: stratified squamous

**J: junction



How did the natural histology benefit the female processes?

****Under the influence of progesterone, the consistency of cervical mucus changes cyclically and plays a significant role in fertilization and early pregnancy.**

- A. At **ovulation**, mucous secretion is abundant and **watery**, facilitating sperm movements into the uterus.
- B. In the **luteal phase**, mucus is more **viscous** helping the passage of sperm.
- C. **During pregnancy**, the cervical glands proliferate and secrete highly **viscous** mucus that forms a plug in the cervical canal.

****Also, the deeper wall of the cervix consists mainly of dense connective tissue, with much less smooth muscle than the rest of the uterus, and thus, the cervix becomes relatively rigid during pregnancy and helps retain the fetus in the uterus.**

- D. **Before parturition**, a process of cervical effacement occurs in which its connective tissue undergoes extensive remodelling and significant collagen removal, mediated in part by macrophages, as a result, the cervix softens, the cervical canal dilates, and birth occurs more easily.

Periodic exposure of the squamous-columnar junction to the vaginal environment can stimulate reprogramming of epithelial stem cells, which occasionally leads to intraepithelial **neoplasia** at that site.

****And now to the outer part, the vagina**

The vagina

Histology

The wall of the vagina **lacks glands** and consists of a mucosa, muscular layer, and an adventitia. {adventitia is **not covered by peritoneum** while serosa is}





Mucosa

- × The epithelium of the vaginal mucosa is **stratified squamous**, with a thickness of 150-200 µm in adults.
- × Stimulated by estrogens, the epithelial cells synthesize and accumulate **glycogen**, and when the cells desquamate, bacteria metabolize glycogen to **lactic acid**, causing a **relatively low pH** within the vagina, which helps **provide protection against pathogenic microorganisms**, also the mucosa normally contains lymphocytes and neutrophils in relatively large quantities.

****The lamina propria of the mucosa is rich in elastic fibers, with numerous narrow papillae projecting into the overlying epithelium.**

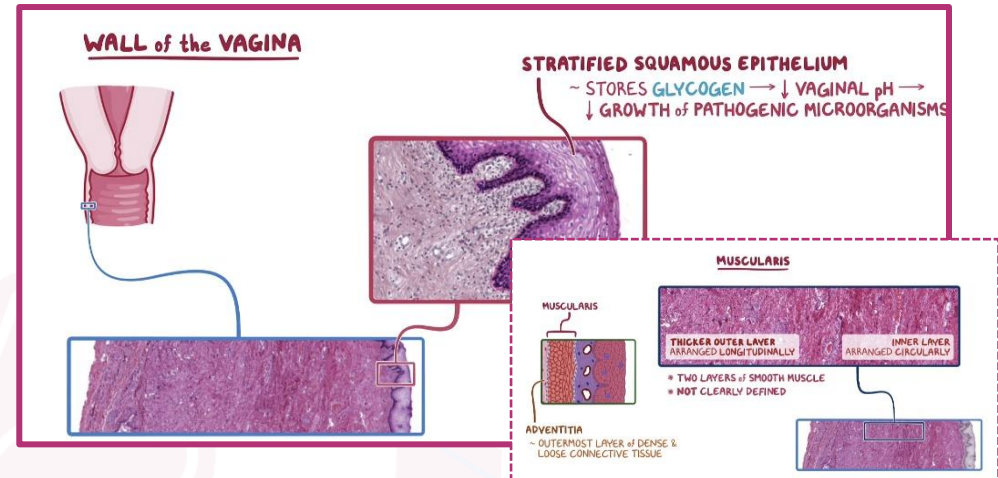
Mucus in the vagina is produced **by the cervical glands**, and **during sexual arousal** lubricating mucus is also provided by glands at the **vaginal vestibule**, including the paired **greater vestibular glands (of Bartholin)**, which are homologous to the male bulbourethral glands.

Muscles

- × The muscular layer of the vagina is composed mainly of **two indistinct layers of smooth muscle**, disposed as **inner circular bundles next to the mucosa and as thicker longitudinal bundles near the adventitial layer**.

Adventitia

- × The dense connective tissue of the adventitia is rich in elastic fibers, making the vaginal wall strong and elastic while binding it to the surrounding tissues, and this outer layer also contains an extensive venous plexus, lymphatics, and nerves.



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Uterus	Cervix
Simple columnar	Simple columnar Except for the cervical region around the external os that projects slightly into the upper vagina which is covered by the exocervical mucosa with nonkeratinized stratified squamous epithelium
Has spiral arteries	Lack spiral arteries
Shed during menstruation, and as a result its thickness does change .	Not shed during menstruation, and as a result its thickness does not change .
CT with More muscles	CT with less muscles
Glands involved in nourishing the embryo.	Glands secrete mucus that facilitates the sperms passage.
Contracts during labour.	Dilates during labour to help in the delivery.



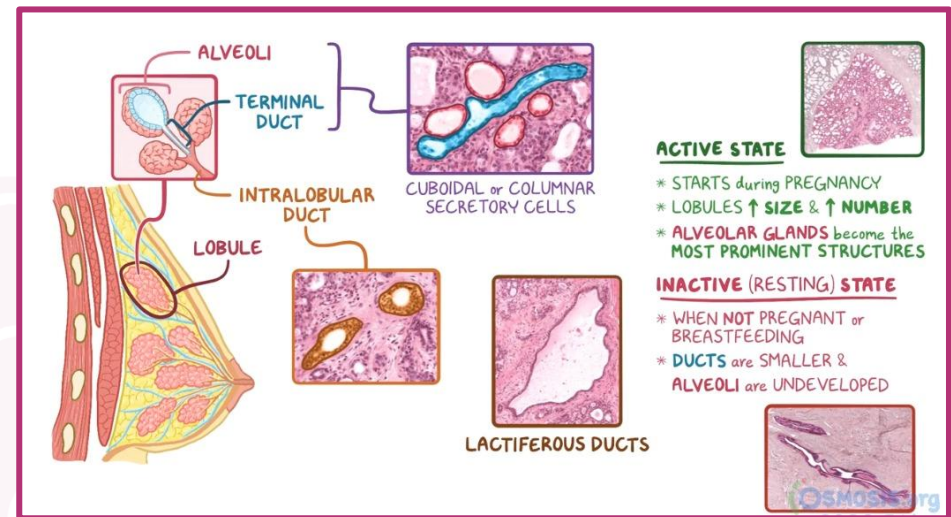
External genitalia (Just naming)

The female external genitalia, or vulva, include several structures, all covered by stratified squamous epithelium:

- A. The vestibule.
- B. The paired labia minora.
- C. The paired labia majora, homologous and histologically like the skin of the scrotum.
- D. The clitoris, an erectile structure homologous to the penis.
- E. Vaginal opening.
- F. Bartholin glands, homologous to the Bulbourethral glands.

Breasts

- × Steps of developing:
 1. Before puberty, same duct system in males and females.
 2. After puberty, under the effect of estrogen the duct system became longer in females. (pregnant or not)
 - A. **Non pregnant:** no lactating, thus, the lactiferous sinuses are small & alveoli. (mature but inactive)
 - B. **After pregnancy:** lactating, increase ducts number and size of sinuses & alveoli.
- × The breast of the female has 15-20 lobes which have lobules inside, these lobes open separately in the ducts (interlobular & lactiferous) which are lined by stratified cuboidal at the inner parts and simple cuboidal at the terminal ones then open to the areola (nipple).



The End

Pictures from: Osmosis.org & Junqueira basic histology 16th edition

