GENERAL GYNECOLOGY NOTES

1. Embryo

2. Menstrual cycle

3. Physiology of the genital tract

4. Anatomy

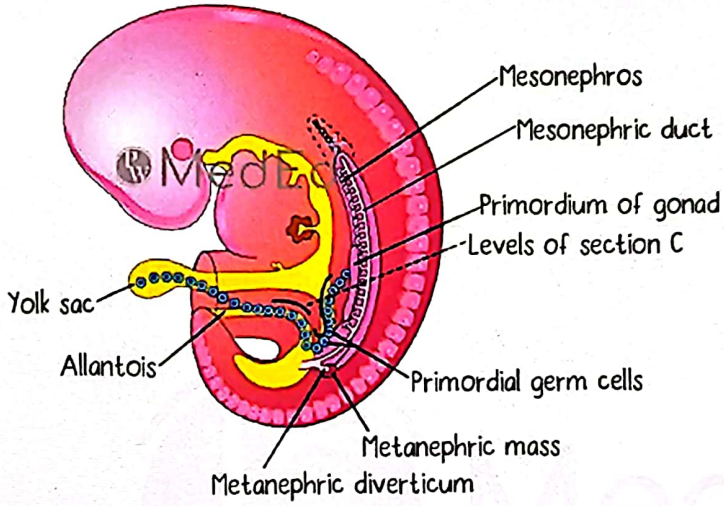
5. Internal genitalia

6. External genitalia

Embryology: Embryology of U
Tract and Normal Pubertal Devel

GONADAL DEVELOPMENT

- Primordial germ cells differentiate in the wall of the yolk sac (3-4 weeks), reach the hind gut epithelium (4 weeks) and migrate to the gonadal area (5 weeks).

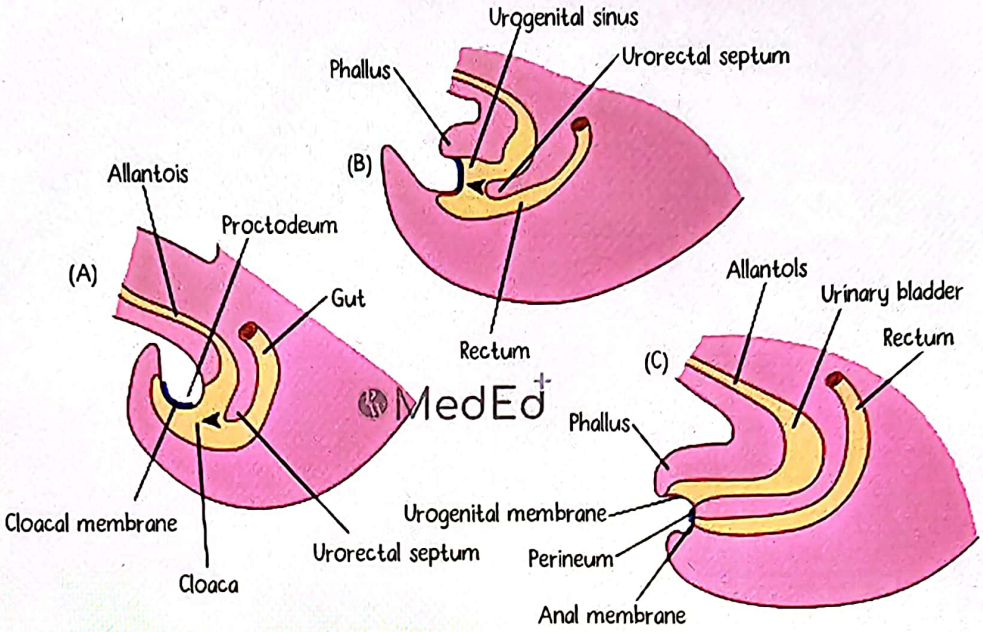


- During 5th Week: Gonadal development occurs.
- Until 7th Week: Gonads are similar in both sexes.
- Gonads are derived from 3 sources
  1. Mesothelium (mesodermal epithelium the coelomic cavity)
  2. Underlying mesenchyme
  3. Primordial germ cells

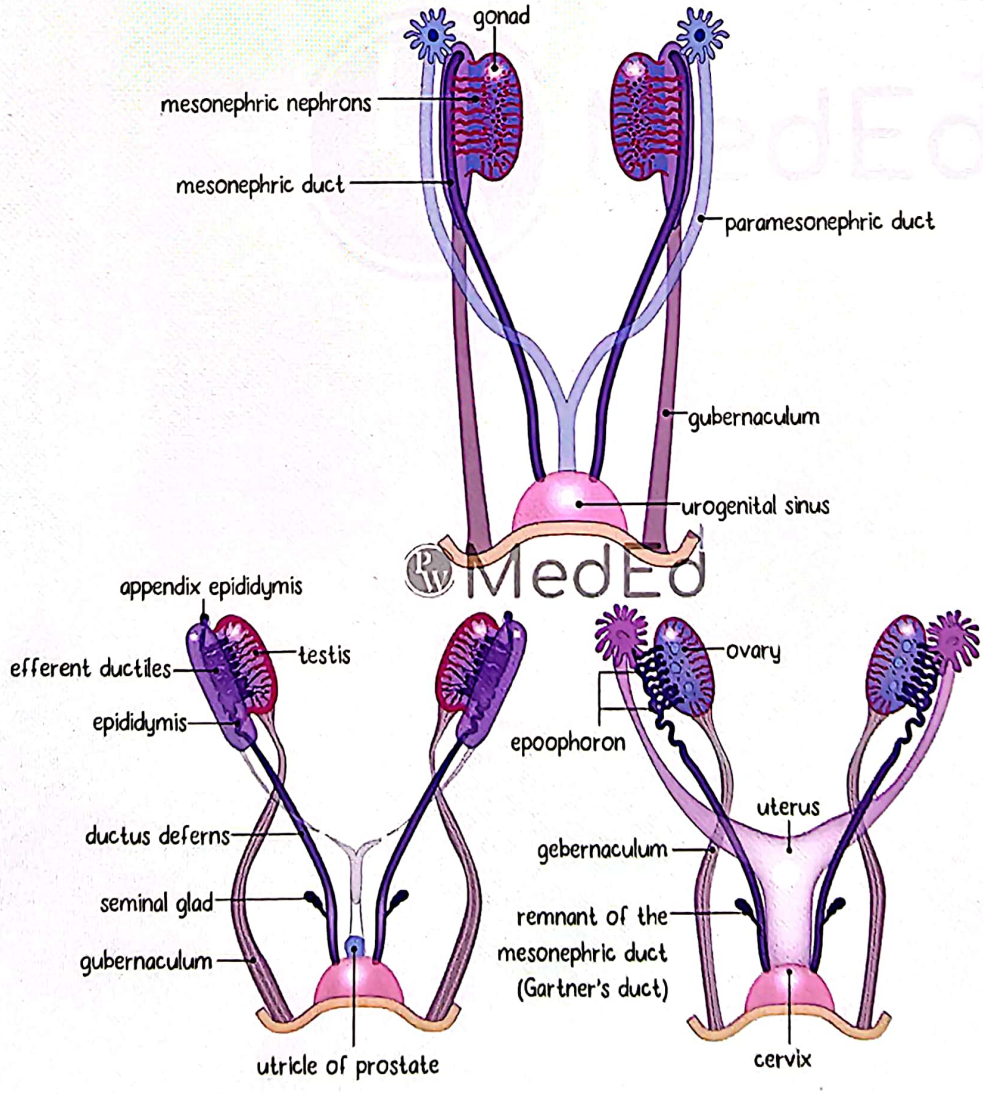
- Bipotential gonads
- They can develop in testes or in ovaries.

DEVELOPMENT OF OVARY

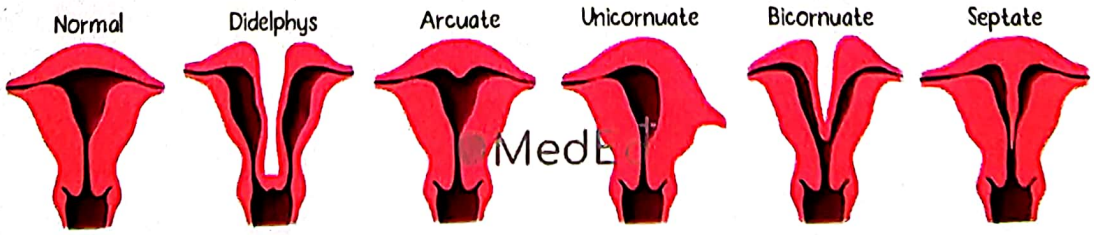
- Cloaca is divided by septum into anterior and posterior part.
- Anterior part forms urogenital sinus (bladder, urethra, lower 2/3 of vagina)
- Posterior part forms a primitive rectum
- Coelomic epithelium on the medial side of mesonephros thickened to form genital ridges (10 weeks).
- Sex cords grow from germinal epithelium into underlying mesoderm.



UTERINE DEVELOPMENT



- Invagination of mesonephric area going down and this is called mesonephric tube.
- Mesonephric tubes form mesonephric ducts.
- Another invagination starts developing lateral to it known as paramesonephric duct. Paramesonephric duct crosses the mesonephric duct from lateral to medial.
- Mesonephric duct is a guide for paramesonephric duct.
- Therefore if there is no mesonephric duct there will be no paramesonephric duct.
- Renal anomalies associated with paramesonephric duct anomalies.
- Paramesonephric duct also known as mullerian duct which forms female internal genitalia.
- Mesonephric duct also known as wolffian duct which forms male internal genitalia.
- Chromosomal sex decides sexual differences.
- The short arm of the Y chromosome has the SRY gene.
- The SRY gene expresses some proteins like SOX-9, FGF-9.
- The SOX-9 gene is responsible for differentiation of the gonad to testes.
- Testes have sertoli cells and leydig cells.
- Sertoli cells secrete AMH (anti mullerian hormone).
- Leydig cells secrete testosterone
- AMH causes regression of paramesonephric ducts.
- Testosterone causes the formation of male internal genitalia.
- Testosterone converts into DHT
- If Y chromosome is absent,
  - No testes
  - No testosterone (wolffian duct will degenerate)
  - No DHT
  - No AMH
- Paramesonephric duct fuse in the midline and unfused part of paramesonephric duct form fallopian tubes.
- Fused part will form the uterus, cervix, upper 1/3 vagina.
- If paramesonephric ducts fail to fuse, it will form two separate uteri and cervices, this is called uterus didelphys.
- If lower part of the paramesonephric duct is fused but the fusion fails to complete all the way to the top, this is called bicornuate uterus.
- If there is a failure of dissolution of uterine septum after fusion is complete, this is called septate uterus.



REMNANTS OF WOLFFIAN DUCT

- Epoophoron
- Paroophoron
- Gartner's duct

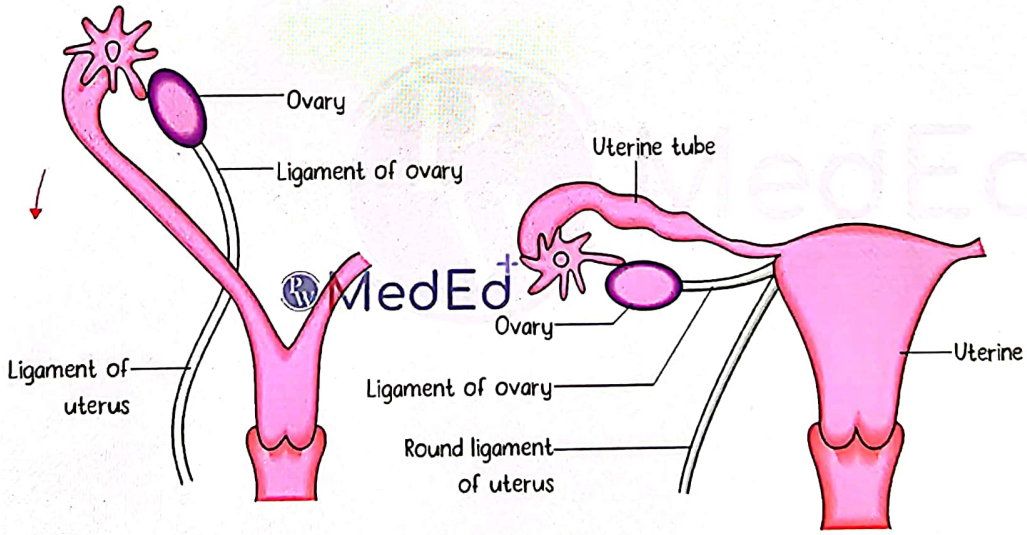
Paramesonephric duct: fuse by 10 weeks

Septum dissolves by 18 weeks

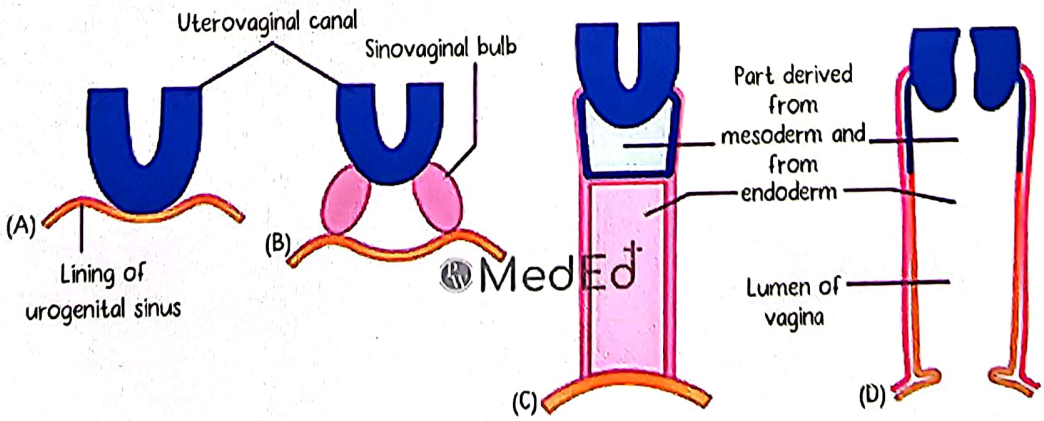
Endometrium is formed around 20 weeks

DESCENT OF OVARY

- Ovary is first formed in the lumbar region (13 weeks) and descends to the true pelvis (at term).
- Gubernaculum is a pathway of gonads from genital ridge to scrotum in male and labia majora in females. While in males this migration is complete, in females, it stops as the ovary comes close to the fallopian tube.
- Modification of gubernaculum in females is ovarian ligament and round ligament.



VAGINAL DEVELOPMENT



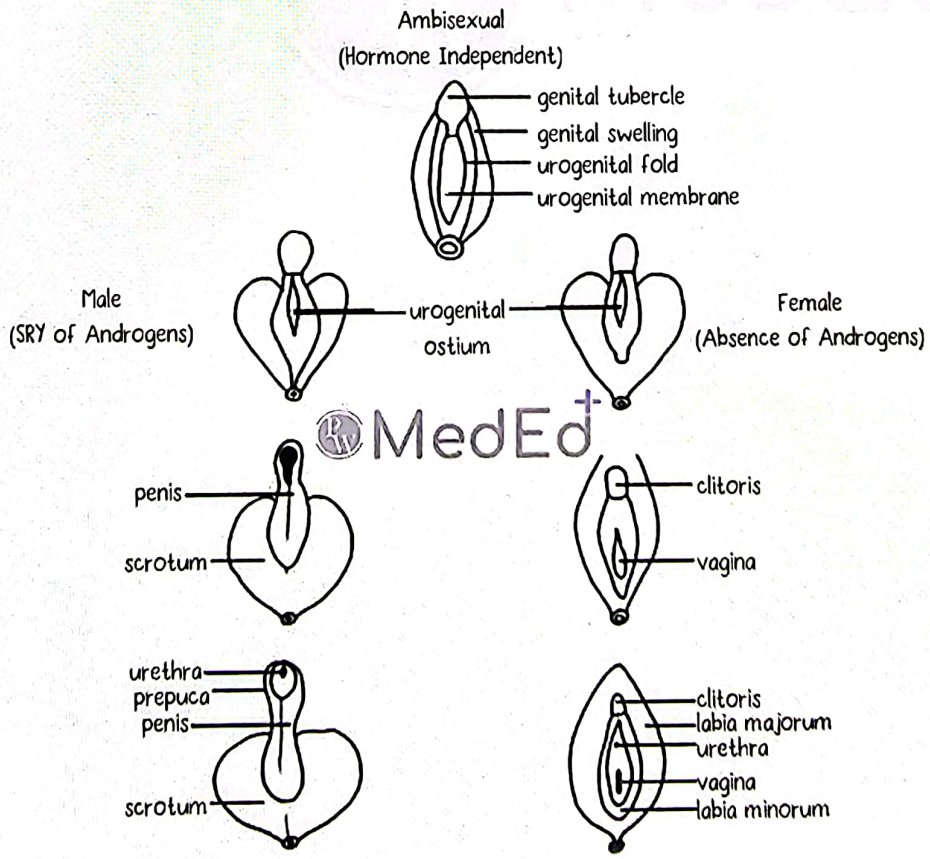
- Sinovaginal bulb is the solid part between the paramesonephric duct and urogenital sinus.
- It forms a solid plate of tissue which dissolves leaving a hollow organ that is the vagina.
- Urogenital sinus remains and forms hymen
- Imperforate hymen leads to primary amenorrhoea and causes cyclic pelvic pain.
- Incomplete canalization of sinovaginal bulb forms transverse vaginal septum.

EXTERNAL GENITALIA

- Formation of external genitalia depends on DHT hormone.
- If DHT present: male external genitalia
- If DHT absent: female external genitalia

Homologous organs:

- In female,
  - Genital swelling - labia majora
  - Genital tubercle - clitoris
  - Urethral folds - labia minora
- In males,
  - Genital swelling - scrotum
  - Genital tubercle - glans penis
  - Urethral folds - penile urethra and penis



PUBERTY

- Age: usually starts at 10-11 years
- Pulsatile secretion of GnRH hormone (at night) causes release of hormones like LH, FSH.
- Breast: due to estrogen (duct) followed by progesterone (alveolar)
- Axillary and pubic hair: due to androgens (adrenal gland)
- Menses: due to FSH and LH
- Before puberty some factors (GABA, neuropeptide Y) inhibit pulsatile release of GnRH.
- At puberty, kisspeptin, glutamate, and leptin give counter effects to initiate GnRH secretion.

SEQUENCE OF EVENTS

Growth spurt

↓

Thelarche (development of breast)

↓

Adrenarche (development of pubic and axillary hair)

↓

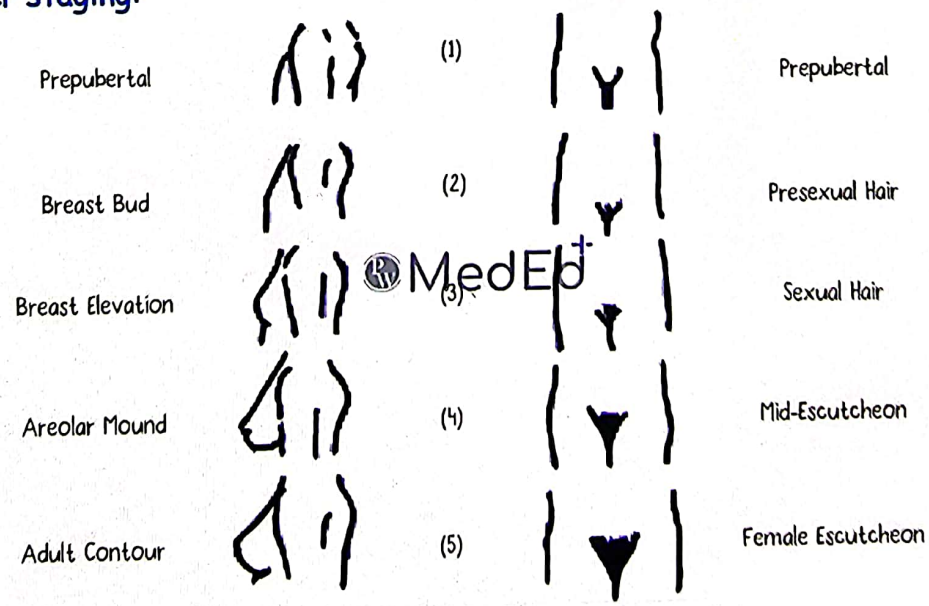
Peak growth velocity

↓

Menarche (menses)

BREAST DEVELOPMENT STAGING

Tanner staging:



Menstrual Cycle

INTRODUCTION

- Cyclical occurrence of menses - flow of blood out of genital tract.
- Combination of two cycles under hormones (hypothalamo-pituitary ovarian axis):
  - Ovarian cycle
  - Endometrial cycle

PHYSIOLOGY

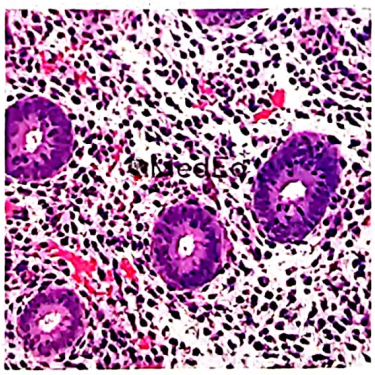
- Hypothalamus secretes gonadotropin releasing hormones in a pulsatile manner.
- It causes an increase in FSH and LH
- FSH - causes growth of dominant follicle
- LH - stimulates the theca cells to secrete androgens, which in the granulosa cell is converted to estrogens (only granulosa cells have aromatase required for conversion).
- Estrogens contribute to the growth of dominant follicles
- Estradiol inhibits FSH, but estradiol at very high concentration and sustained increase stimulates LH.

OVARIAN CYCLE

- Around puberty - 3-4 lakh oocytes in ovaries
- Oocytes are surrounded by follicular cells called granulosa cells - preantral follicles.
- FSH causes accumulation of fluid/antrum, oocyte is eccentrically placed - antral follicle.
- Antral follicle is seen as small hypoechoic round structures which measure < 10mm.
- Under effect of FSH and estrogen (aromatized from androgens in theca cells) - antral follicle grows in size and becomes large.
- Secondary oocyte is surrounded by granulosa cells and that is surrounded by theca cells - Graafian follicle (18mm).
- Connecting stalk - discus proligens and granulosa cells surrounding the oocyte - cumulus oophorus.
- LH surge is responsible for ovulation
- Ovulation - extrusion of secondary oocyte from graafian follicle
- Ovulation occurs around 36 hours after LH surge
- After ovulation, the graafian follicle is composed of polyhedral cells which are full of yellow pigment - corpus luteum.
- Corpus luteum secretes progesterone
- If fertilization does not occur corpus luteum degenerates by the 23rd day of cycle - decrease in progesterone - menses.

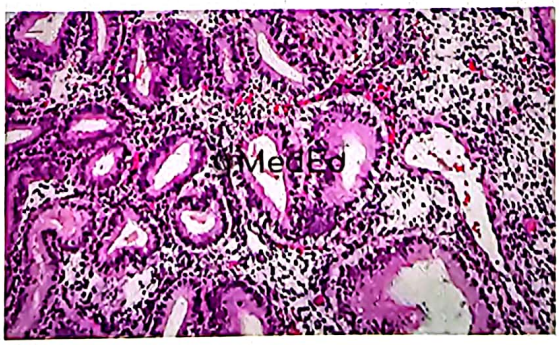
ENDOMETRIAL CYCLE

- 1st phase (proliferative phase)- end of menses to ovulation(usually around day 14 in a 28 day cycle):
  - Increased FSH - antral follicles grow
  - Increased estrogen - endometrial proliferation - increased stroma and fewer glands.
- 2nd phase (luteal phase/secretory phase: fixed: 14 days) - day of ovulation to onset of menses:
  - LH surge - ovulation - oocyte escapes to the fallopian tube
  - Graafian follicle - corpus luteum - increased progesterone secretion.
  - Progesterone - makes the endometrium secretory - more glands and more branching in the glands and secretions are seen within the gland.
- 3rd phase (menstrual phase) - start to end of bleeding:
  - Corpus luteum degenerates - sudden drop in progesterone - menstrual phase/bleeding phase.
  - Endometrium - deep layer and superficial layer. Superficial 2/3rds of endometrium bleeds.
  - Stratum basalis which is around 1 mm remains
  - Vasospasm of vessels in the superficial layer of endometrium - necrosis and endometrial bleeding.
- Lots of stroma and round glands with tall columns of epithelial cells and lots of stroma and lesser glands - proliferative phase - under the effect of estrogen.



Proliferative phase

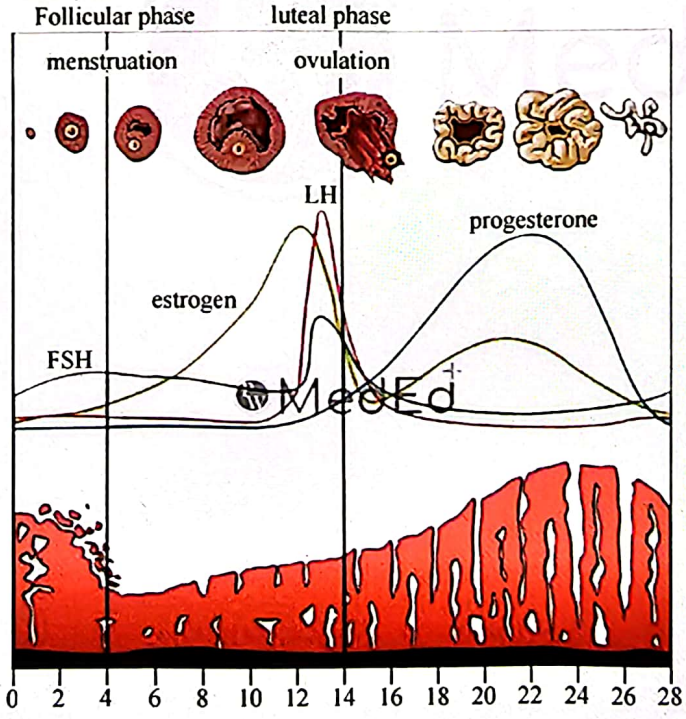
- Lots of glands, more branched and convoluted and secretions within the glands - secretory phase.



Secretory phase

MENSTRUAL CYCLE SUMMARY

- At the level of endometrium:
  - Day 1 - first day of menses Thickness of the endometrium decreases - menstrual phase.
  - Then it starts to increase till D14 - proliferative phase
  - Progesterone maintains the thickness and makes it glandular till D28 - secretory phase.
- At the level of ovary:
  - At the beginning of the cycle, 10 -15 follicles are recruited and under the effect of FSH only one becomes dominant/graafian follicle.
  - Until the D14 graafian follicle gets bigger
  - D14 - ovum is extruded from graafian follicle - ovulation Graafian follicle is converted to corpus luteum.
  - Corpus luteum(CL) produces progesterone until it disappears on D23.
- Hormones:
  - Progesterone - appears only after CL is formed and remains at peak till D23 after which it starts decreasing.
  - LH - massive surge just before ovulation and then drops off.
  - FSH - keeps increasing till graafian follicle development But the peak is smaller than LH
  - Estrogen - dual peak/double hump.

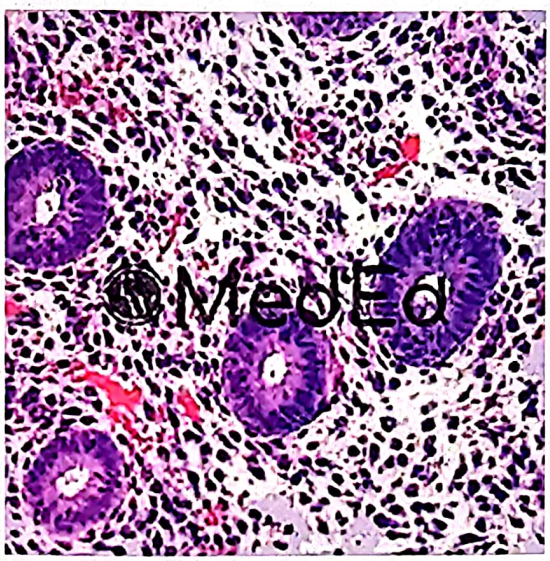


ANOVULATION

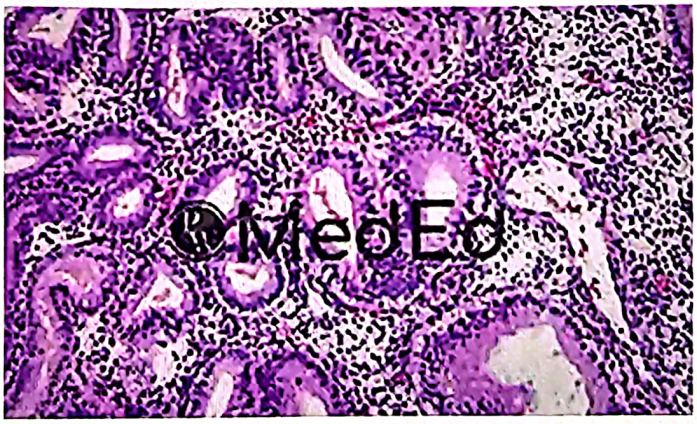
- No ovulation
- Graafian follicle is not converted to CL - no progesterone
- Remember: Menses is not a result of absence of progesterone. It is a result of withdrawal of progesterone.

General Gynecology
Physiology of Genital Trac

UTERUS



Estrogen stromal + ductal proliferation

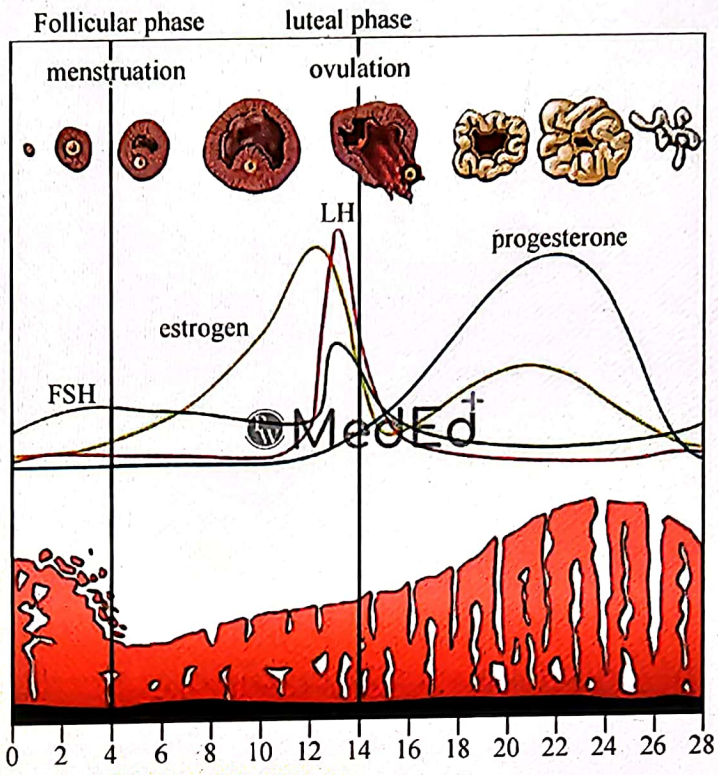


Decidualization: progesterone mediated changes

- Progesterone mediated changes
- Ductal branching
- Less stroma
- Duct secretion

MYOMETRIUM

- Estrogen causes myohyperplasia
- Increase receptivity of oxytocin receptors on myocytes
- Progesterone decreases sensitivity to oxytocin
- Progesterone prevents abortion and preterm labor



FALLOPIAN TUBE

- Estrogen increases the motility of cilia in the fallopian tube.
- Progesterone increases the secretion from the fallopian tube and decreases ciliary motility.

CERVIX

- Estrogen effect on cervix: cervical mucus becomes thin and watery and rich in sodium chloride and formation of fernning pattern.
- Progesterone protects pregnancy and prevents any ascending infection, it makes a very thick and tacky plug.

VAGINA

- Estrogen causes cornification and thickening of vagina
- Increased mitotic activity causes more energy use
- Glycogen converts into lactic acid and lactic acid maintains the acidic pH of vagina.
- Progesterone causes more intermediate cells

BREAST

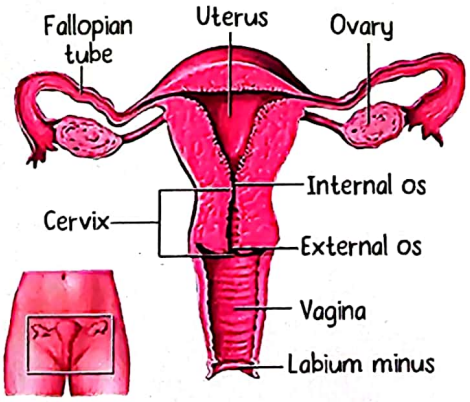
- Estrogen causes ductal growth and proliferation
- Progesterone causes alveolar growth and proliferation

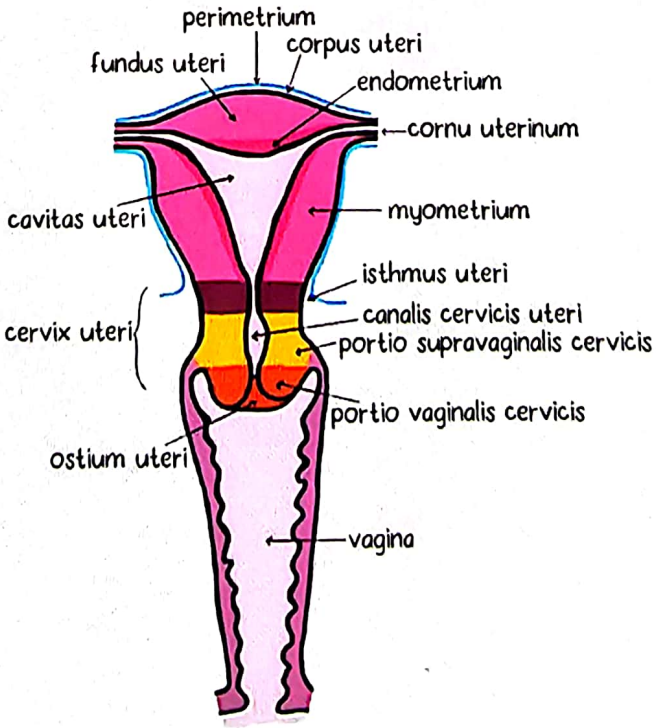
Organ	Estrogen	Progesterone
Uterus	Proliferative endometrium Myohyperplasia and increase sensitivity to oxytocin	Secretory endometrium
Cervix	Secretion is thin and watery	Mucus thick and tacky
Fallopian tube	Increase ciliary motility	Increases secretion and relatively decrease motility
Vagina	Cornification, thickening and acidic pH, more superficial cells	More intermediate cells
Breast	Ductal proliferation	Alveolar proliferation

Anatomy of Genital Tract: Internal Genitalia

UTERUS

- The upper part of the uterus is known as the body of the uterus/corpus of the uterus/uterine corpus.
- Cervix has 2 parts:
  1. Supravaginal portion - portion above the vagina
  2. Portio vaginalis - portion of the cervix within the vagina
- Internal os - opening between the corpus and the cervix
- External os - opening between the cervix and vagina
- The cervix lies between the internal os and the external os.





Size and weight:

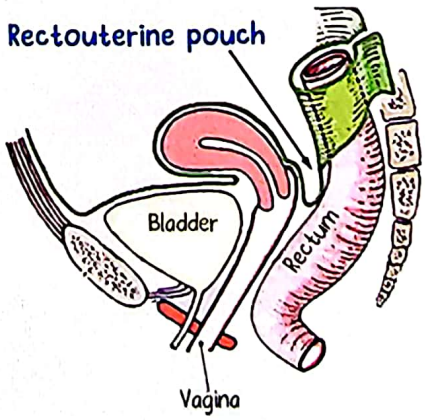
- Normally, the uterus weighs around 50-70 grams and measures 3 x 2 x 1 inches.
- During pregnancy, the weight of the uterus is almost 1.1 kg due to hyperplasia and hypertrophy.

Corpus to Cervix ratio:

- Premenarche - 1 : 2
- At puberty - 2 : 1
- Reproductive age group - 3 : 1
- Postmenopause - 1 : 1

CERVIX

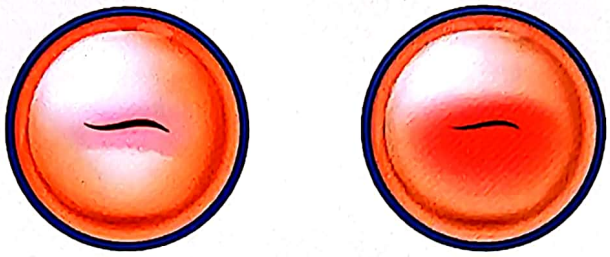
- Internal os is the anatomical distinction between the uterus and cervix.
- Histologically, the endometrial tissue of the uterus extends a little beyond the internal os after that, the endocervical tissue starts.
- The part of the cervix lined by the endometrial tissue is known as the Isthmus.
- Isthmus elongates and forms the lower uterine segment during pregnancy.
- Over the uterus, the peritoneum is tightly attached, but at the point of the isthmus, it is loosely attached.
- This loose fold of the peritoneum is called a uterovesical fold.
- During C-section, a cut is made on this loosely attached peritoneum which helps to push down the bladder exposing the lower uterine segment to make an incision.



- The endocervix has tall columnar epithelium, while the ectocervix has stratified squamous non-keratinized epithelium.
- Squamo-columnar junction (SCJ) - the point where the epithelium of the endocervix and ectocervix meet.
- SCJ is a dynamic point with a tendency to move inwards with age and sexual intercourse.

Ectropion

- The columnar epithelium is visible on the portio vaginalis.
- Before onset of sexual activity, increased estrogen exposure
- Early in life, the SCJ is seen on the ectocervix



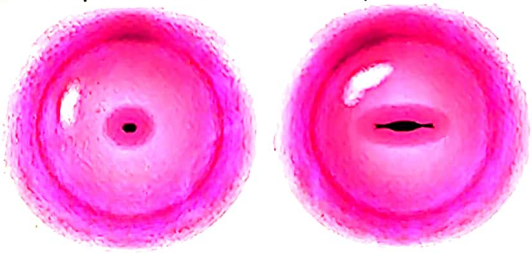
HEALTHY CERVIX CERVICAL ECTROPION

- With sexual activity, there is metaplasia at the SCJ.
- The columnar epithelium starts receding inwards, and there is a shift in the SCJ due to the metaplasia.
- Transformation zone - the zone where metaplasia occurs and the columnar epithelium is replaced by stratified squamous epithelium.

Note: The transformation zone is not equal to the SCJ, but it is the area of metaplasia between the old SCJ and the new SCJ.

	Nulliparous	After childbirth
Cervix	Conical	Barrel shaped
External os	Pin-point	Slit-like

a Nulliparous Cervix b Multiparous Cervix

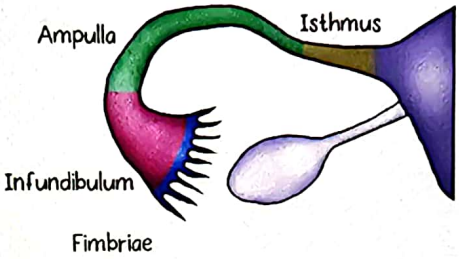


Note: Cervix and external os in females who had elective C-sections is the same as that of a nulliparous female.

FALLOPIAN TUBE

- A part of the fallopian tube lies inside of the uterus, known as the intramural part of the fallopian tube (narrowest part overall).
- The fallopian tube arises from the angle of the uterus, which is known as the cornu of the uterus.
- Structures arising from the angles of the uterus are known as cornual structures (anteriorly to posteriorly: round ligament, fallopian tube and ovarian ligament).

- The narrowest part of the fallopian tube (intraperitoneal) which is within the pelvic cavity is the isthmus.
- The widest part is known as the ampulla, it is also the site of fertilization.
- The final part with finger-like projections is known as the infundibulum/fimbrial part of the fallopian tube.



- The fallopian tube has columnar ciliated epithelium and PEG cells within it.
- The cilia help the sperm move towards the egg and fertilize it at the ampulla.
- Cilia makes a rowing action towards the endometrium for implantation of the conceptus.
- The fallopian tube epithelium also provides secretions for the nourishment of the conceptus.

Clinical correlations:

Tubal block at the level of cornu	No entry of sperm.	Infertility
Fimbrial end block	Oocyte not picked up.	Infertility
Cilia destroyed	No movement of conceptus to the endometrial cavity.	Tubal pregnancy (ectopic pregnancy)/ infertility

Ruptured ectopic pregnancy:

- The fallopian tube bursts open after a point where it cannot stretch with an increase in the size of the baby.
- It is a gynecological emergency.
- Ectopic pregnancy in the isthmus is the first to rupture.

Isthmus	Ampulla	Intramural part
6 weeks	8 weeks	10 weeks

Pelvic inflammatory disease:

- Ascending infection travels through the tube into the pelvic cavity and causes inflammation of peritoneal surfaces.
- Peritonitis, abscess, ovarian infection.

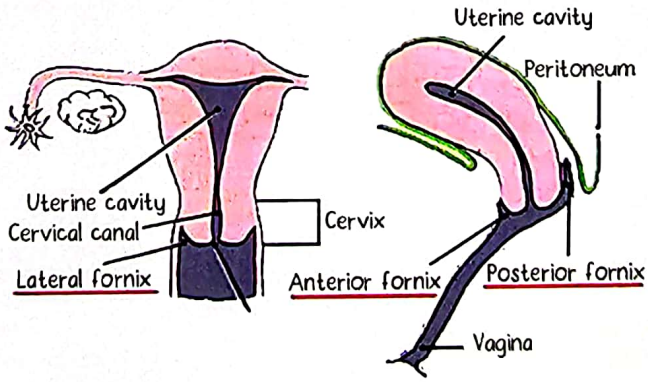
VAGINA

- Stratified squamous non-keratinized epithelium of the ectocervix continues in the vagina as well.

- Vagina has anterior, posterior, and lateral fornices.
- The posterior fornix is the deepest.
- The length of the posterior vaginal wall (10cm) is longer than the length of the anterior vaginal wall (7cm).

Fornices:

- In bimanual examination, when fingers are placed within the fornices, the adnexal structures (ovary and fallopian tube) can be felt.
- Palpation of lateral fornices gives information about adnexal masses or pathologies.
- Posteriorly, there is a loose fold of peritoneum between the uterus and rectum, forming a pouch known as the pouch of Douglas/cul de sac.
- In the upright position, the pouch of Douglas is the most dependent portion of the pelvis.
- On USG, fluid accumulation in the pouch of Douglas is seen as a hypoechoic streak behind the uterus and in front of the rectum.
- In suspected cases of ruptured ectopic pregnancy, blood is found by aspirating the pouch of Douglas by placing a needle through the posterior fornix.
- This is also useful in cases pelvic abscess, where pus may be aspirated from the pouch of Douglas.
- This process of aspiration from POD (cul-de-sac) is known as culdocentesis.



- Vagina has no glands, but the secretion comes from the endocervical glands and the paraurethral glands of the skene.
- The paraurethral glands of the skene secrete fluids during coitus.

ATTACHMENTS OF UTERUS

Angle of anteversion:

- The angle between the vagina and the cervix (90°)

Angle of anteflexion:

- The angle between the cervix and the uterus (105°-120°)

Uterosacral ligament:

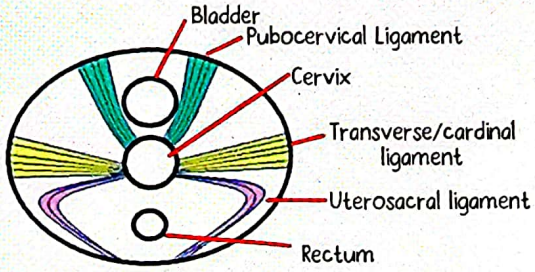
- Pseudoligaments (paired) that go from the uterus to the sacrum
- Starts from the isthmus of the cervix and joins to the sacrum.
- This ligament pulls the cervix, so the uterus bends anteriorly.

Transverse cervical ligament:

- Also known as the cardinal ligament/Machenrodt ligament.
- Goes from the pelvic sidewall and joins the cervix
- These are also not true ligaments

Pubocervical ligament:

- Slightly weaker ligament
- Goes from the cervix to the pubic symphysis



- These ligaments cause the angles of anteversion and anteflexion of the uterus and the cervix.

Ovarian ligament:

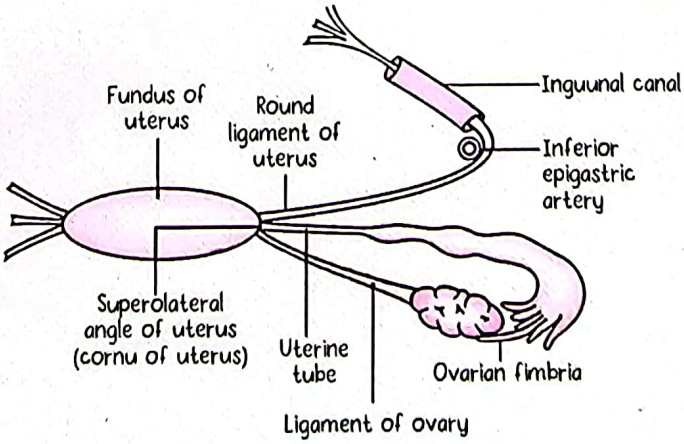
- Connects each ovary to the lateral side of the uterus

Infundibulopelvic ligament:

- Attaches the ovary to the pelvic sidewall
- Carries the blood supply to the ovary, through the ovarian artery.

Round ligament:

- One side of the round ligament attaches to the cornu of the uterus.
- This ligament passes through the deep inguinal ring, goes into the inguinal canal, and emerges at the superficial inguinal ring.
- It attaches outside to the labia majora



Broad ligament:

- A double-layered sheath of peritoneum that is draping over the cornual structures.
- It attaches the later portions of the uterus to the lateral pelvic sidewalls.

BLOOD SUPPLY

The common iliac artery branches out from the aorta and has 2 branches, the external iliac artery and the internal iliac artery.

- The external iliac artery goes downwards to supply the thigh.
- While the internal iliac artery goes inside the true pelvis.
- The internal iliac artery lies posteriorly to the ovary and along with it lies the ureter.

Ovarian fossa:

- Superiorly - external iliac artery
- Posteriorly - internal iliac artery and the ureter
- Floor - obturator nerves and vessels

Ovarian artery:

- Direct branch from the aorta
- It supplies the ovary and the fallopian tube
- It also has certain anastomosis with the uterine artery.

Uterine artery:

- The first branch to come out from the anterior division of the internal iliac artery.
- Around 2 cm lateral to the cervix, the ureter flows under the uterine artery.
- This is known as water under the bridge
- Common point of ureteric injuries
- Ascending branch of the uterine artery - gives blood supply to the uterus and anastomoses with the ovarian artery.
- The uterine artery also gives a descending branch and the vaginal branch.

Vaginal artery:

- It branches out from the uterine artery or directly from the internal iliac artery.
- It supplies the upper part of the vagina.

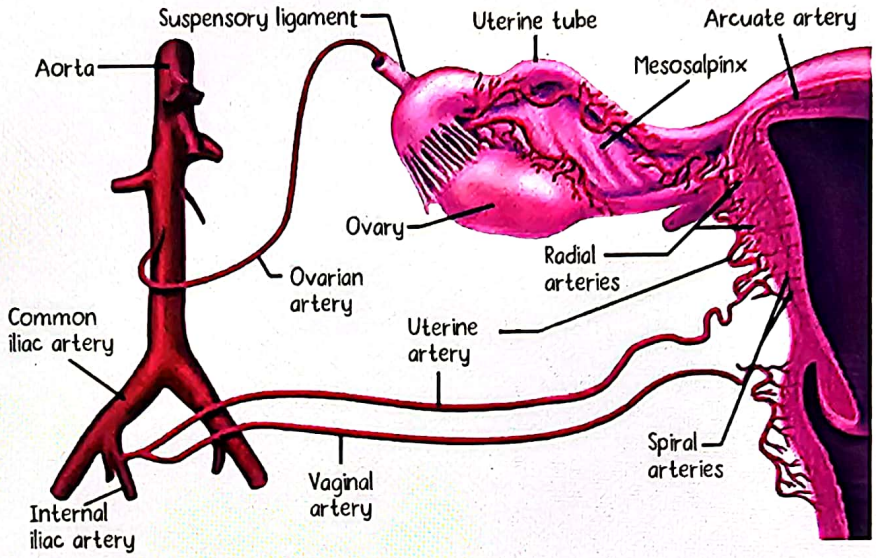
Internal pudendal artery:

- It is also a branch of the anterior division of the internal iliac artery.
- It supplies the lower part of the vagina.
- Can lead to vulvar hematoma during episiotomy.

Sampson's artery:

- It is the artery of the round ligament of the uterus.
- It constitutes anastomosis of the uterine and ovarian artery.

- The round ligament is tied in abdominal and vaginal hysterectomy, and coagulated in laparoscopic hysterectomy to avoid bleeding from the Sampson artery.



Stepwise devascularization in postpartum hemorrhage:

- The uterine artery is ligated at the water under the bridge point.
- If bleeding is not stopped, then at the anastomotic point of the ovarian and uterine artery.
- Eventually, the internal iliac artery is ligated if others fail to stop the bleeding.

Oophorectomy:

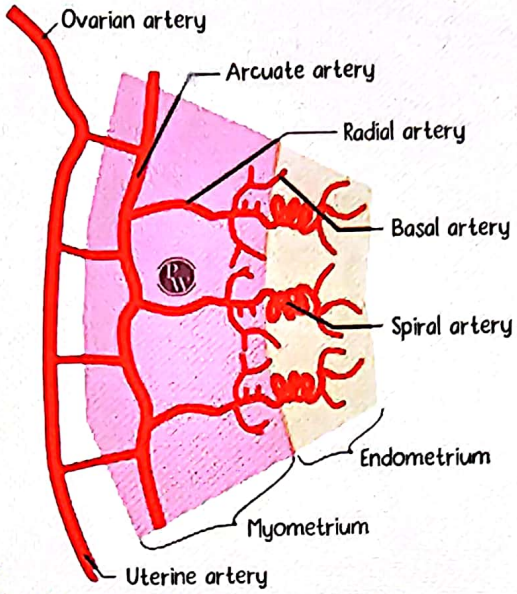
- There can be an injury to the ureter because it lies posterior to the infundibulopelvic ligament.
- The pelvic brim is the most common site of ureteric injury.

Ovarian cancer:

- Can penetrate into the obturator nerve and vessel bed.
- Lead to referred knee pain

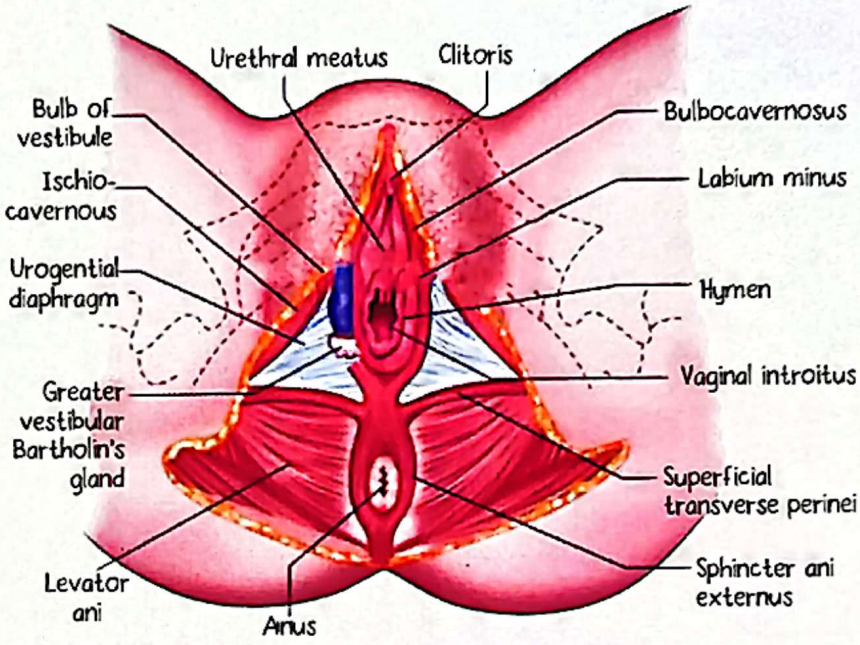
Arcuate artery:

- The uterine artery goes into the uterus and divides making arcs known as the arcuate arteries.
- The arcuate artery further divides and sends vessels to the center, known as the radial arteries.
- Radial arteries supply the myometrium and will divide into the basal artery and the spiral artery.
- The basal artery supplies the lowermost layer (lower third) of the endometrium (basal layer).
- The spiral artery supplies the superficial endometrium (upper 2/3rd).

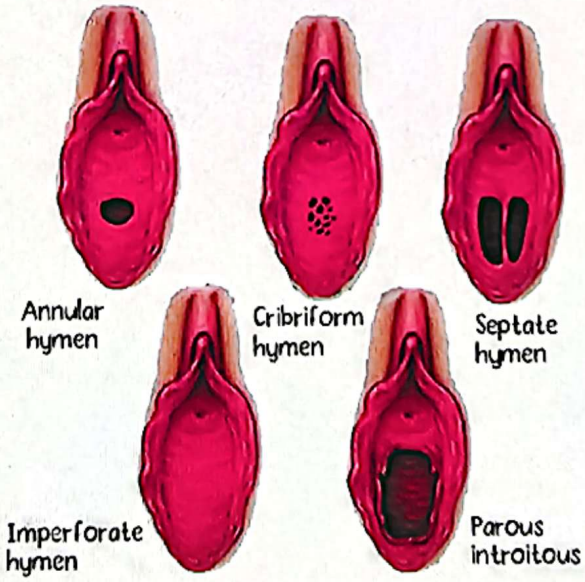

Ovarian artery
Arcuate artery
Radial artery
Basal artery
Spiral artery
Endometrium
Myometrium
Uterine artery

External Genitalia

SURFACE ANATOMY



HYMEN



- Most common form of hymen → annular hymen
- Not an indicator of virginity
- Not only sexual intercourse that breaks the hymen
- Activities that break hymen → Bike riding, horse riding, tampon use.

Imperforate hymen:

- No outlet for menstrual blood
- Distention of vagina due to blood accumulation → Hematocolpos
- Distention of uterus due to blood accumulation → Hematometra

Symptoms:

- Primary amenorrhea
- Cyclical abdominal pain
- O/E : Tense bluish bulge
- P/R : Tender bulge anteriorly just after entering the anal verge

Treatment:

- Cruciate incision

Blood supply of vulva:

- Internal pudendal artery
- Mons → Branch of external pudendal artery
- Vulvar hematoma → due to internal pudendal artery

Lymphatic drainage:

- Superficial inguinal lymph node → Deep inguinal lymph node → pelvic lymph node (External iliac lymph node)
- Vulva → midline structure have a bilateral drainage
- In ca vulva - Lesion is in vulva then both sides lymph nodes should be removed.

Nervous supply:

Vulva

↓

Mostly by Pudendal nerve

Near mons

↓

Genital branch of genitofemoral nerve

And Posterior cutaneous nerve of thigh

Near the inguinal canal

↓

Ilioinguinal nerve

BARTHOLIN GLANDS

- Also known as greater vestibular gland
- Present in superficial perineal pouch
- 1 on either side
- Homologous to cowper's glands in male
- Ducts open between anterior ⅔ and posterior ⅓ of introitus

Bartholin Cyst:

- May be asymptomatic, some pain, dyspareunia, difficulty in sitting.
- If infection present → Bartholin's abscess (warm, red, tender, pain, fever)

Course of action:

- Word's catheter → Drainage
- Recurrent after catheter & drainage → Marsupialization
- Abscess → Antibiotic
- > 40 years → Risk of cancer → Biopsy

Word's catheter