Reproductive anatomy

Part 1: External generative organs

INA S. IRABON, MD, FPOGS, FPSRM, FPSGE
OBSTETRICS AND GYNECOLOGY
REPRODUCTIVE ENDOCRINOLOGY AND INFERTILITY

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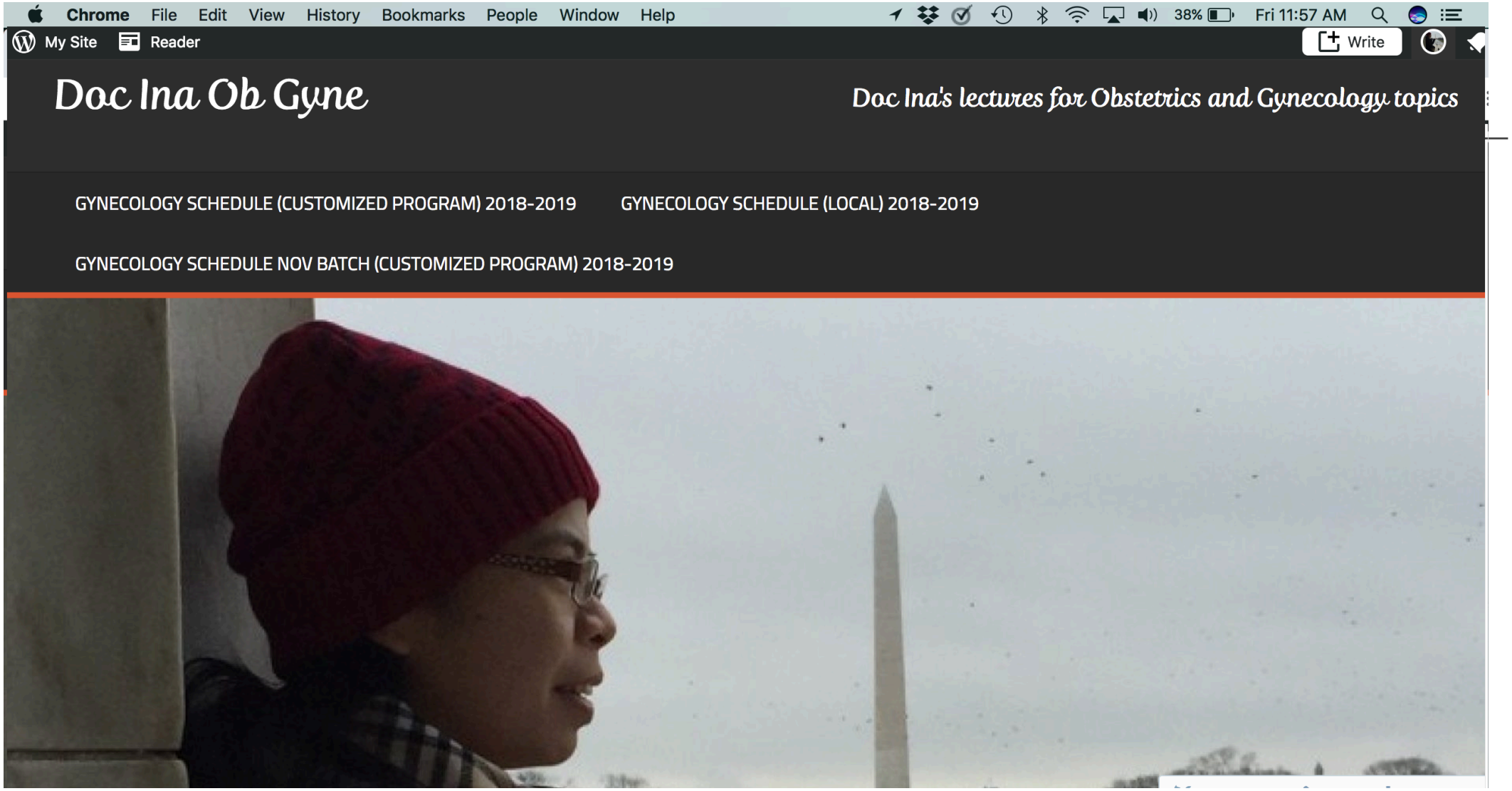


Reference

Comprehensive Gynecology 7th edition, 2017 (Lobo RA, Gershenson DM, Lentz GM, Valea FA *editors)* chapter 3, Reproductive anatomy

Cunningham FG, Leveno KJ, Bloom SL, Spong CY, Dashe JS, Hoffman BL, Casey BM, Sheffield JS (eds).William's Obstetrics 25th edition; chapter 2

Outline

1. Vulva
2. Mons pubis
3. Labia majora
4. Labia minora
5. Clitoris
6. Vestibule
7. Skene glands
8. Bartholin glands
9. Vestibular glands
10. Hymen
11. Vagina

Perineum:

- Anterior trianagle
- Posterior triangle
- Urethra
- Pelvic diaphragm
- Pudendal nerve

1.Vulva

- The *vulva*, or *pudendum/pudenda,* is a collective term for the external genital organs that are visible in the perineal area
- The vulva consists of the following: the mons pubis, labia majora, labia minora, hymen, clitoris, vestibule, urethra, Skene glands, Bartholin glands, and vestibular bulbs
- The boundaries:
  - mons pubis anteriorly
  - rectum posteriorly (perineal body)
  - from one lateral genitocrural fold to the other.
- The entire vulvar area is covered by keratinized, stratified squamous epithelium. The skin becomes thicker, more pigmented, and more keratinized as the distance from the vagina increases.

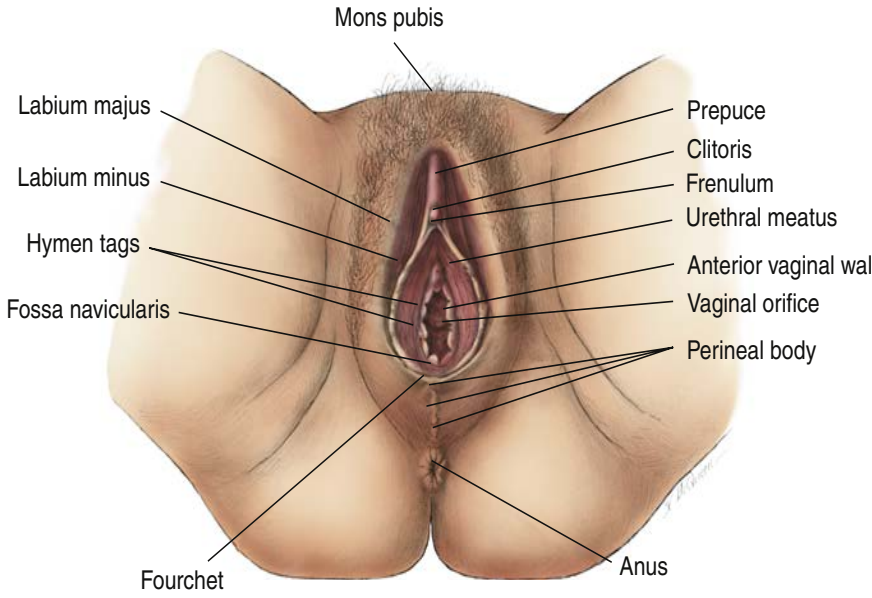


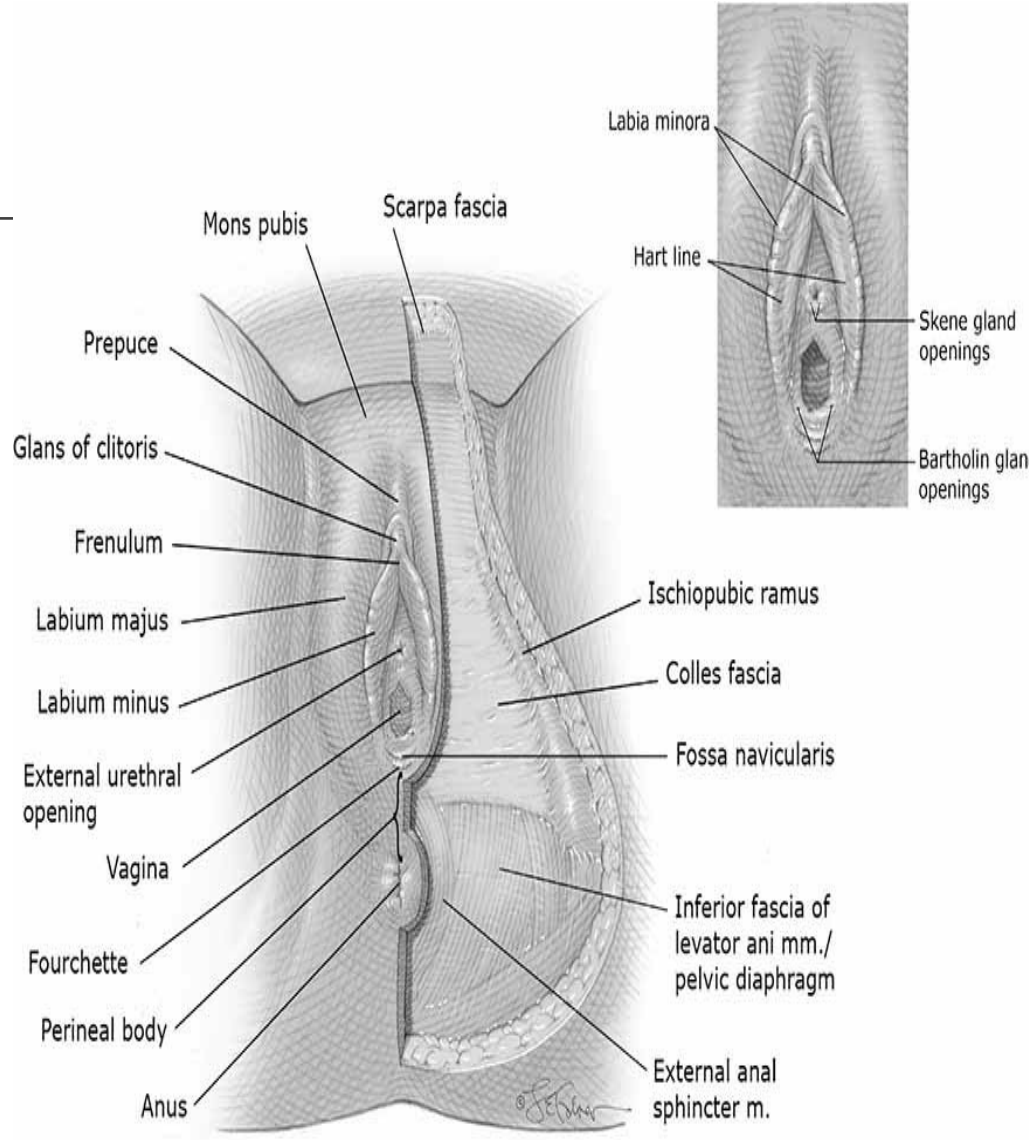
Figure 3.1 The structures of the external genitalia that are collectively called the *vulva*. (Modified from Pritchard JA, MacDonald PC, Gant NF. *Williams' Obstetrics*. 17th ed. New York: Appleton-Century-Crofts; 1985:8.)

1.Vulva

- The vulva receives innervations and vascular support from the pudendal nerve
- Vulvar trauma such as straddle injuries frequently results in large hematomas or profuse external hemorrhage.
- The richness of the vascular supply and the absence of valves in vulvar veins contribute to this complication.
- The abundant vascularity of the region promotes rapid healing, with low incidence of wound infection in episiotomies or obstetric tears of the vulva.

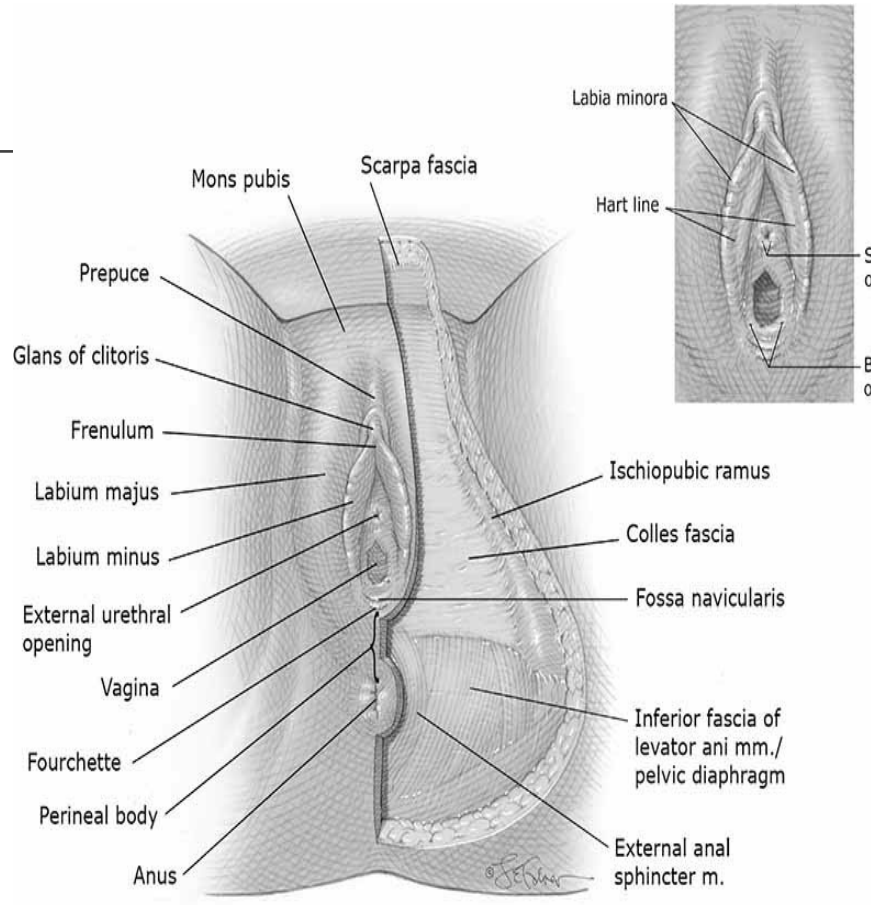
2. Mons Pubis

- A fatty, rounded eminence that develops hair after puberty.
- It is directly anterior and superior to the symphysis pubis.
- The hair pattern, or ***escutcheon***, of most women is triangular.
- Genetic and racial differences produce a variety of normal hair patterns, with approximately one in four women having a modified escutcheon that has a diamond (male-like) pattern.



3. Labia Majora

- two large, longitudinal, cutaneous folds of adipose and fibrous tissue.
- Each labium majora is approximately 7 to 8 cm in length and 2 to 3 cm in width.
- The labia extend from the mons pubis anteriorly to become lost in the skin between the vagina and the anus in the area of the posterior fourchette.
- The skin of the outer convex surface of the labia majora is pigmented and covered with hair follicles.
- The thin skin of the inner surface does not have hair follicles but has many sebaceous glands.

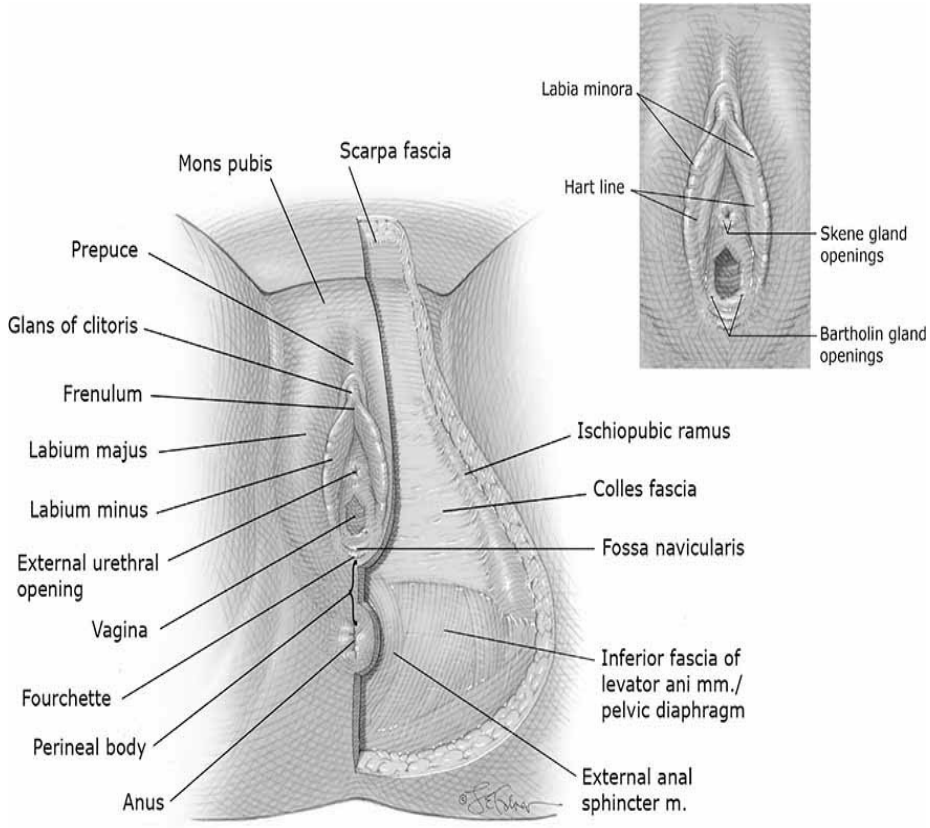


3. Labia Majora

- labia majora have both sweat and sebaceous glands
- The apocrine glands are similar to those of the breast and axillary areas.
- The size of the labia is related to fat content.
- Usually the labia atrophy after menopause.
- *The labia majora are homologous to the scrotum in the male.*

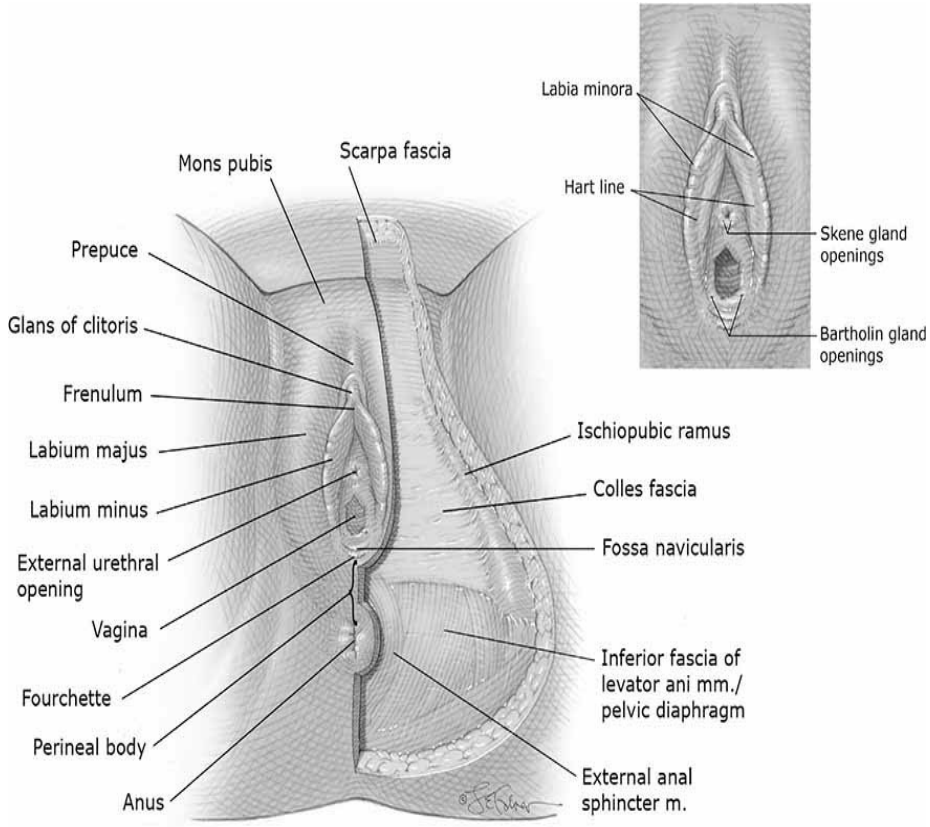
3. Labia Majora

- The subcutaneous fatty tissue of the labia majora and mons pubis are in continuity with the fatty tissue of the anterior abdominal wall.
- Infections in this space such as cellulites and necrotizing fasciitis are poorly contained and may extend cephalad in rapid fashion.
- the round ligaments terminate at their upper borders



3. Labia Majora

- fat mass of the labia provides bulk to the labia majora and is supplied with a rich venous plexus.
- During pregnancy, this vasculature may develop varicosities, especially in multiparas, from increased venous pressure created by the enlarging uterus.
- They appear as engorged tortuous veins or as small grapelike clusters, but they are typically asymptomatic and require no treatment.

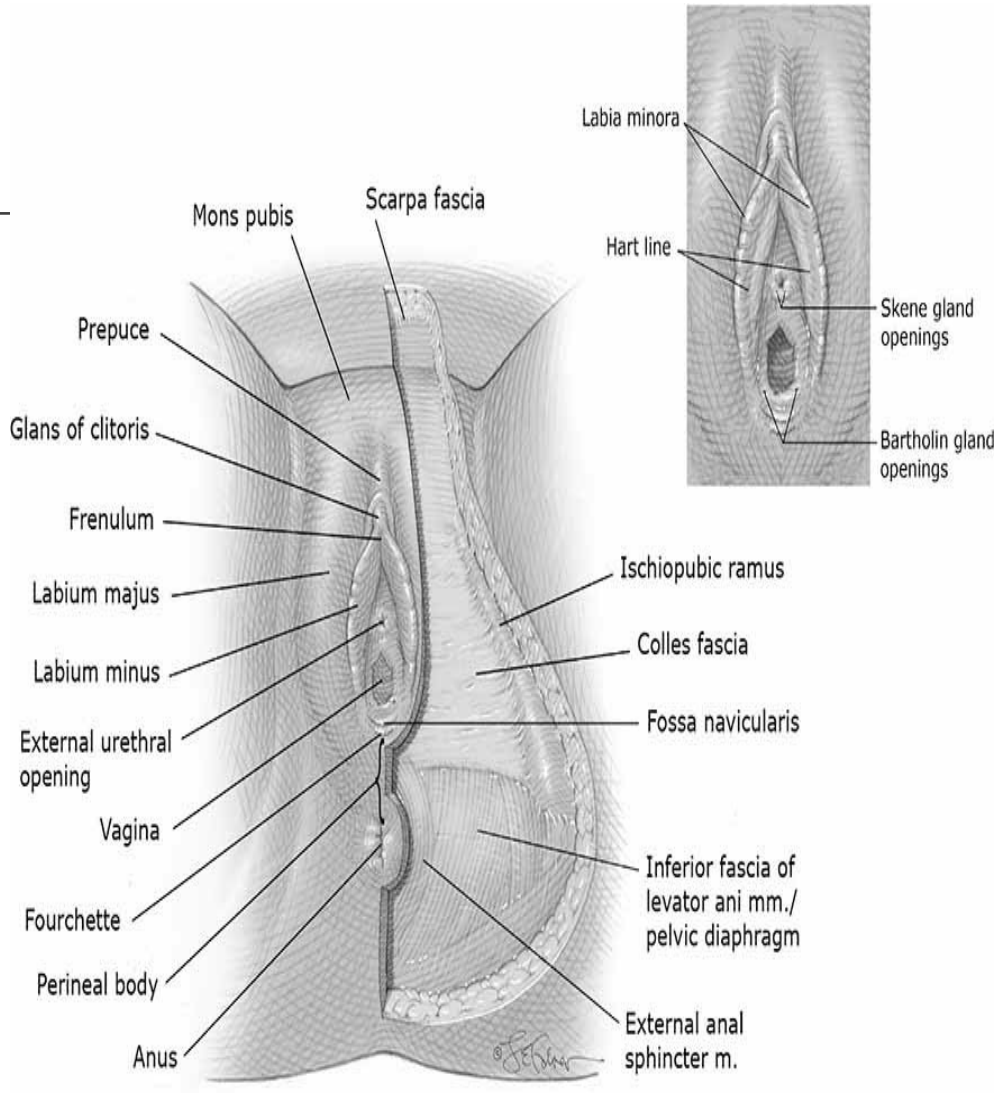


4. Labia Minora

Each labium minora is a thin tissue fold that lies medial to each labium majora.

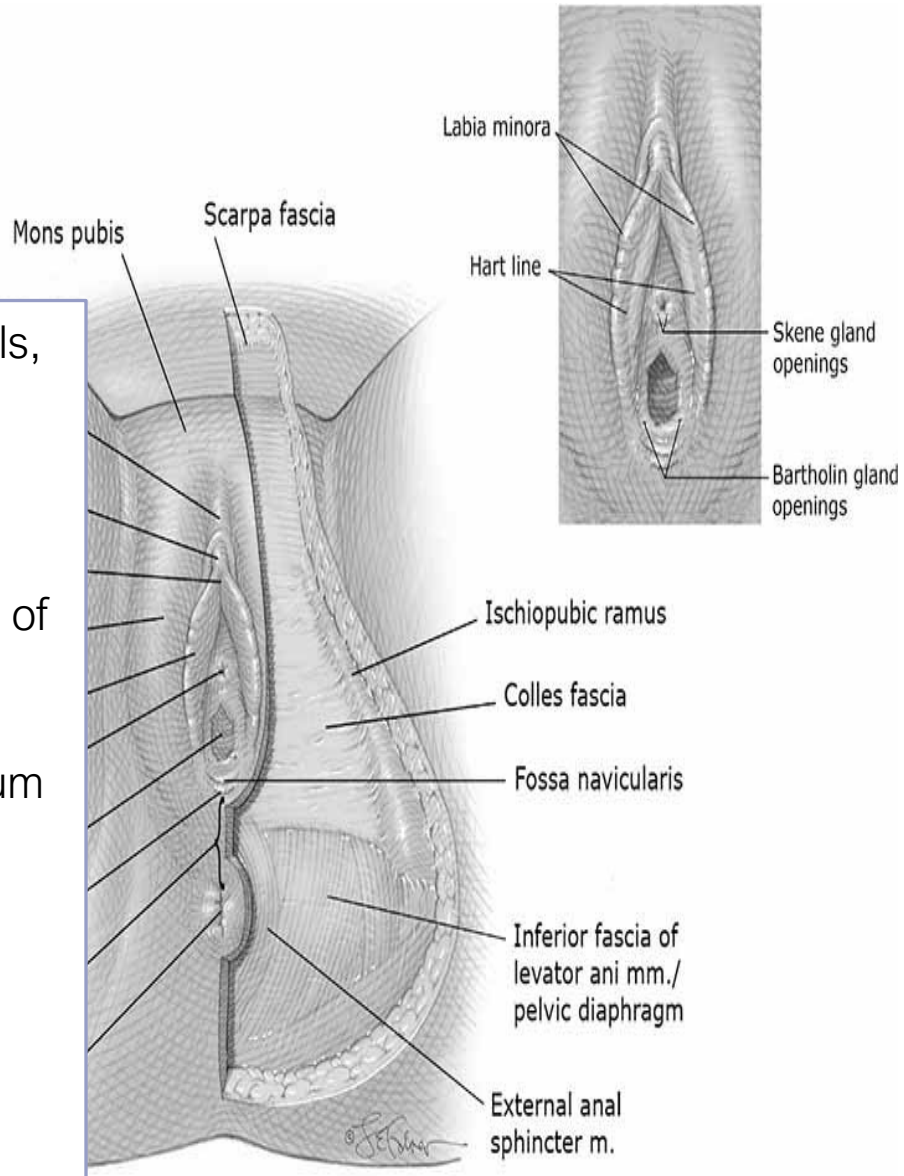
The labia minora extend superiorly, where each divides into two lamellae. From each side, the lower lamellae fuse to form the frenulum of the clitoris, and the upper lamellae merge to form the prepuce

Inferiorly, the labia minora extend to approach the midline as low ridges of tissue that join to form the fourchette.



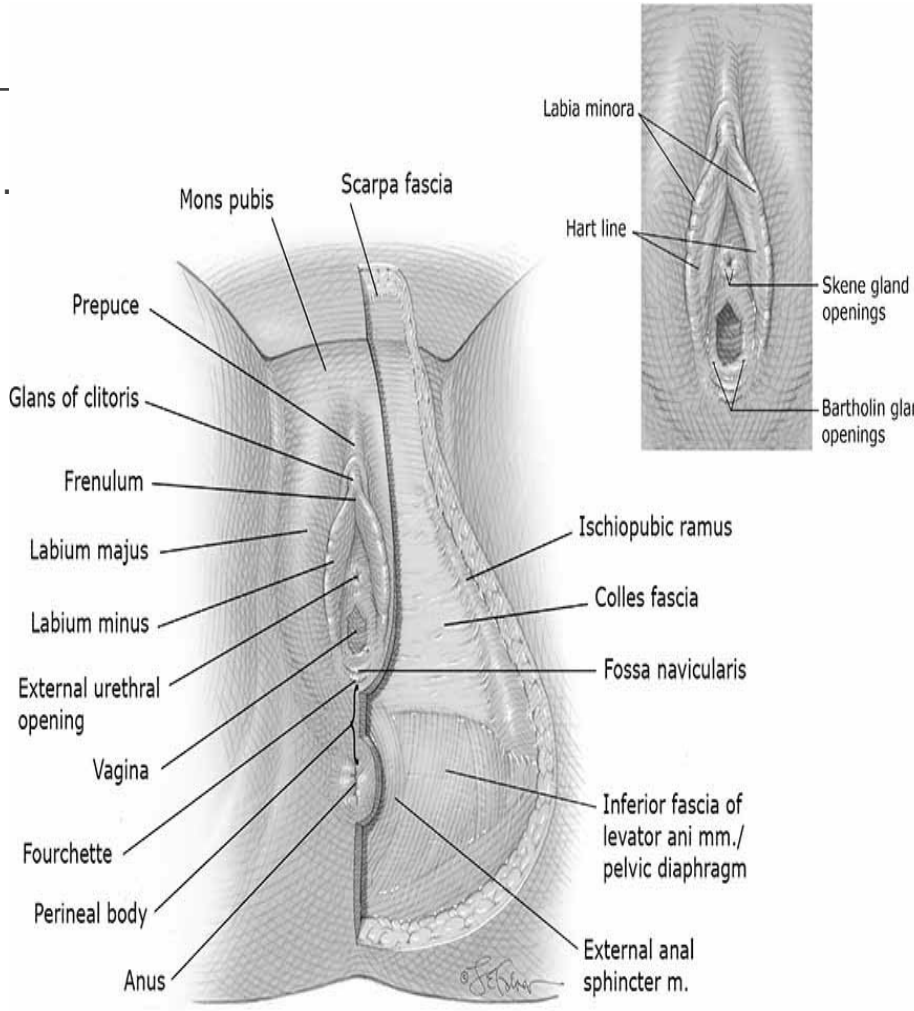
4. Labia Minora

- the labia minora are composed of connective tissue with numerous vessels, elastin fibers, and very few smooth muscle fibers.
- They are supplied with many nerve endings and are extremely sensitive
- Thinly keratinized stratified squamous epithelium covers the outer surface of each labium.
- On their inner surface, the lateral portion is covered by this same epithelium up to a demarcating line, termed Hart line.
- Medial to this line, each labium is covered by squamous epithelium that is nonkeratinized.
- The labia minora lack hair follicles, eccrine glands, and apocrine glands. However, sebaceous glands are numerous



5. Clitoris

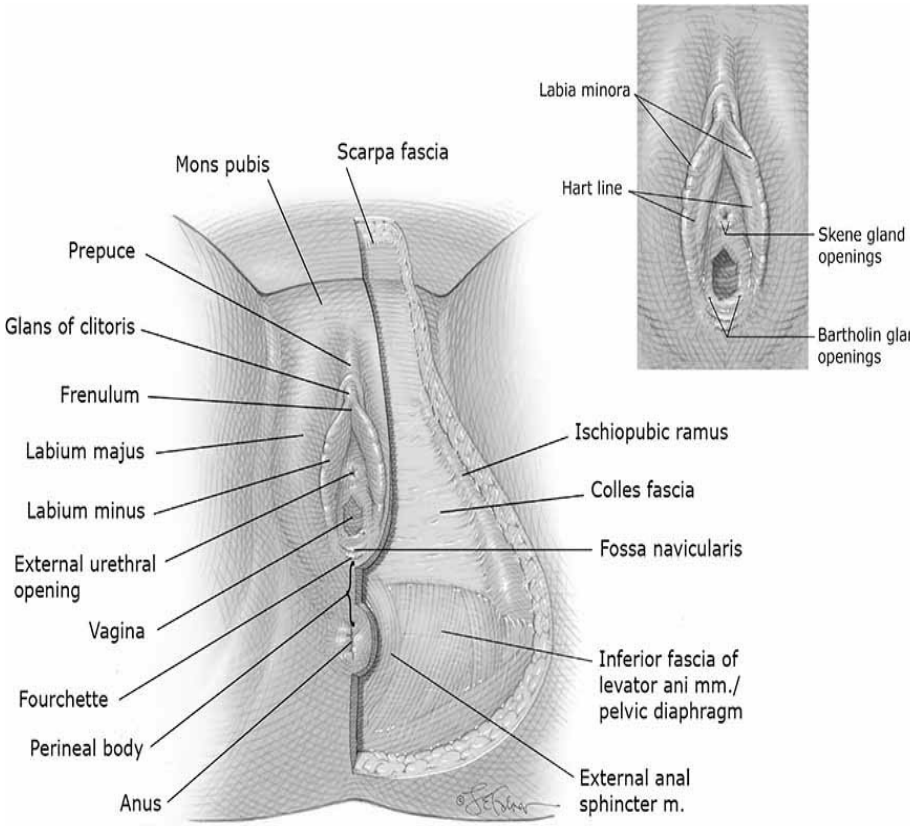
- short, cylindric, erectile organ at the superior portion of the vestibule.
- The clitoris rarely exceeds 2 cm in length and is composed of a glans, a corpus or body, and two crura
- The two crura attach to the periosteum of the symphysis pubis.
- The body has two cylindric corpora cavernosa composed of thin-walled, vascular channels that function as erectile tissue
- The distal one third of the clitoris is the glans, which has many nerve endings.
- *The clitoris is the female homologue of the* ***penis in the male****.*



5. Clitoris

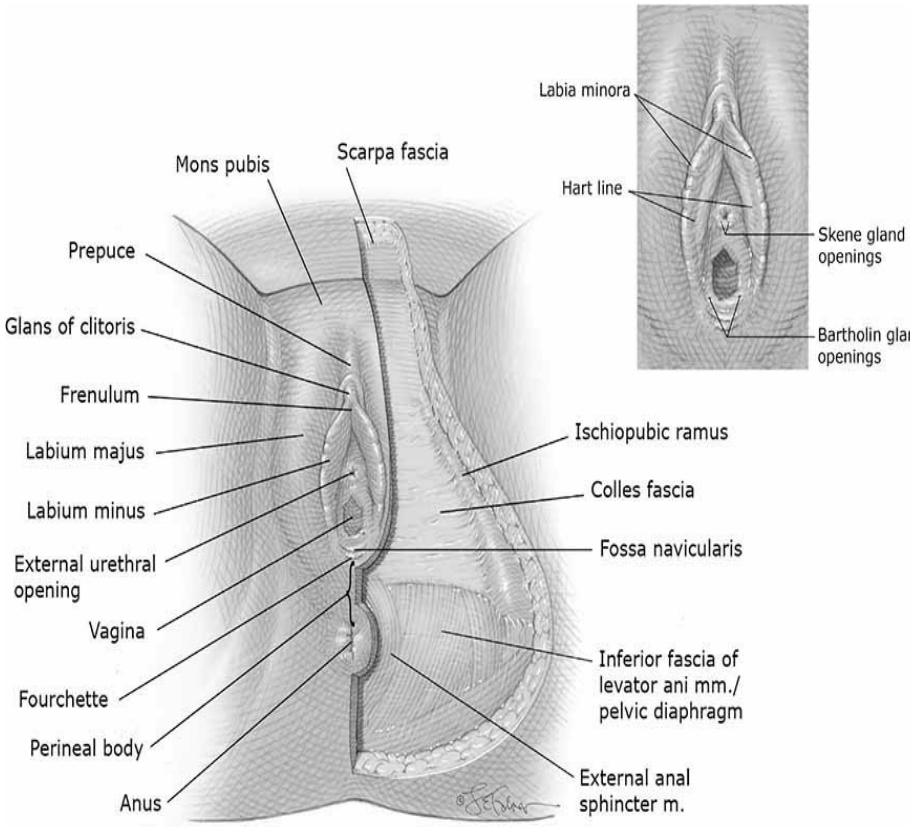
The clitoral blood supply stems from branches of the internal pudendal artery.

Specifically, the deep artery of the clitoris supplies the clitoral body, whereas the dorsal artery of the clitoris supplies the glans and prepuce.



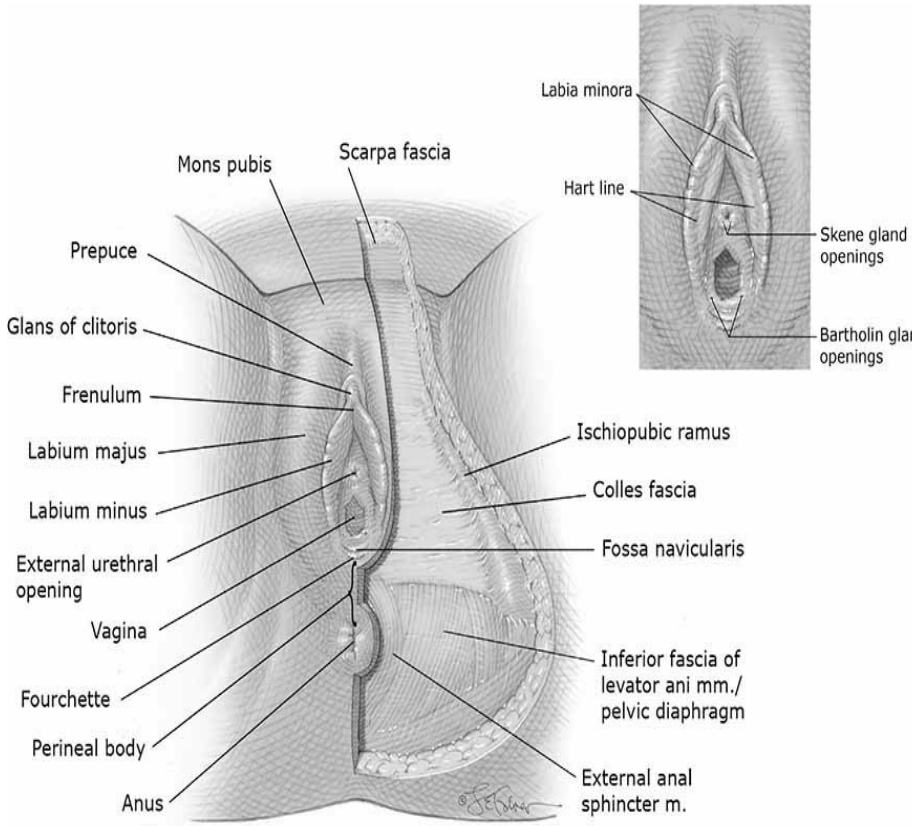
6.Vestibule

- lowest portion of the embryonic urogenital sinus.
- It is the cleft distal to the vagina between the labia minora that is visualized when the labia are held apart.
- The vestibule extends from the clitoris to the posterior fourchette.
- The orifices of the urethra and vagina and the ducts from Bartholin glands open into the vestibule.
- Within the area of the vestibule are the remnants of the hymen and numerous small mucinous glands.



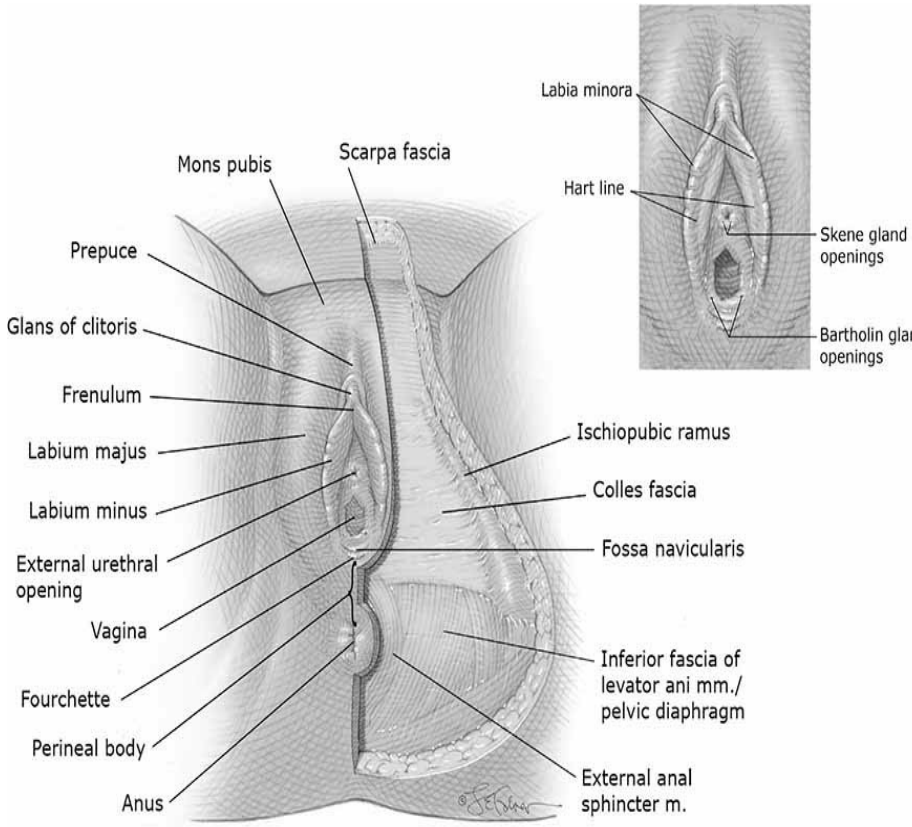
6.Vestibule

- In adult women, the vestibule is an almond-shaped area that is enclosed by Hart line laterally, the external surface of the hymen medially, the clitoral frenulum anteriorly, and the fourchette posteriorly
- The vestibule is usually perforated by six openings: the urethra, the vagina, two Bartholin gland ducts, and two ducts of the largest paraurethral glands—the Skene glands.
- The posterior portion of the vestibule between the fourchette and the vaginal opening is called the *fossa navicularis*. It is usually observed only in nulliparas.



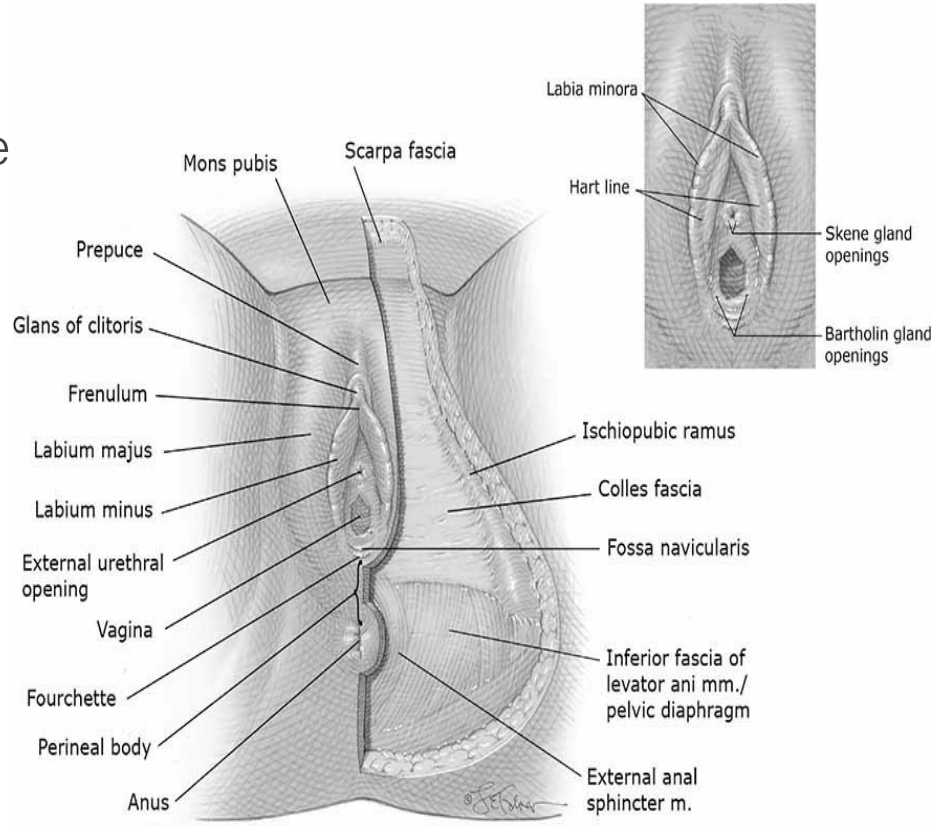
7. Skene glands

- Also called *paraurethral glands*, are branched, tubular glands that are adjacent to the distal urethra.
- ducts open into the area just outside the urethral orifice.
- Skene glands are the largest of the paraurethral glands;
- Clinically, inflammation and duct obstruction of any of the paraurethral glands can lead to urethral diverticulum formation.
- *Skene glands are homologous to the* ***prostate in the male.***



8. Bartholin glands ("greater vestibular glands")

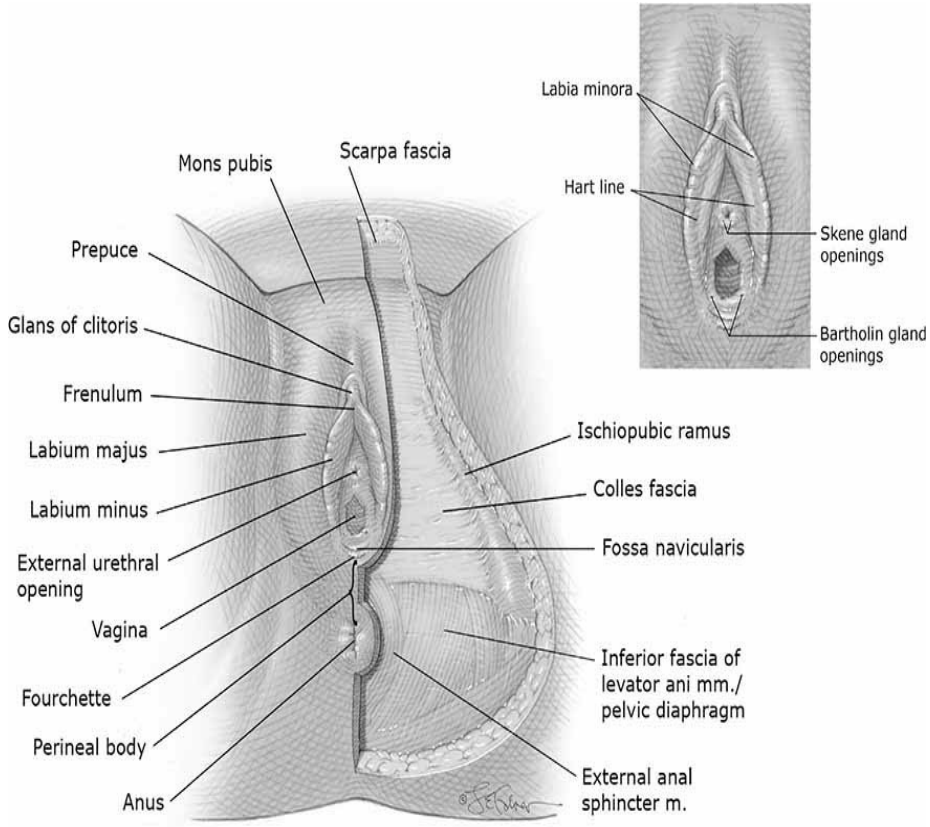
- located immediately beneath the fascia at about 5 and 7 o'clock positions (others would say 4 and 8 o'clock), respectively, on the posterolateral aspect of the vaginal orifice (about the size of a pea)
- composed of cuboidal epithelium; duct from each gland is lined by transitional epithelium and is approximately 2 cm in length.
- Bartholin ducts open into a groove between the hymen and the labia minora.
- *Bartholin glands are homologous to* ***Cowper glands in the male.***



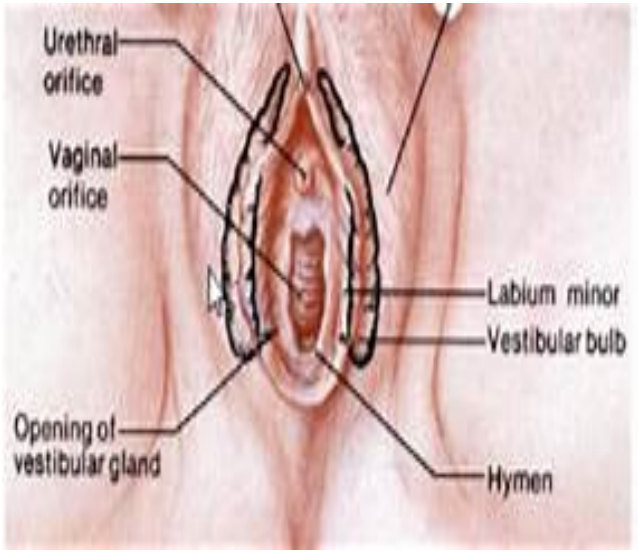
8. Bartholin glands ("greater vestibular glands")

- Following trauma or infection, either duct may swell and obstruct to form a cyst → *Bartholin gland cyst*

- If the Bartholin gland cyst becomes infected → *Bartholin gland abscess* (very painful)



9.Vestibular bulbs



- The vestibular bulbs are two elongated masses of erectile tissue situated on either side of the vaginal orifice.
- Each bulb is immediately below the bulbocavernosus muscle.
- The distal ends of the vestibular bulbs are adjacent to Bartholin glands.
- They are homologous to the *bulb of the penis in the male*.

10. Hymen

The hymen is a membrane of varying thickness that surrounds the vaginal opening more or less completely.

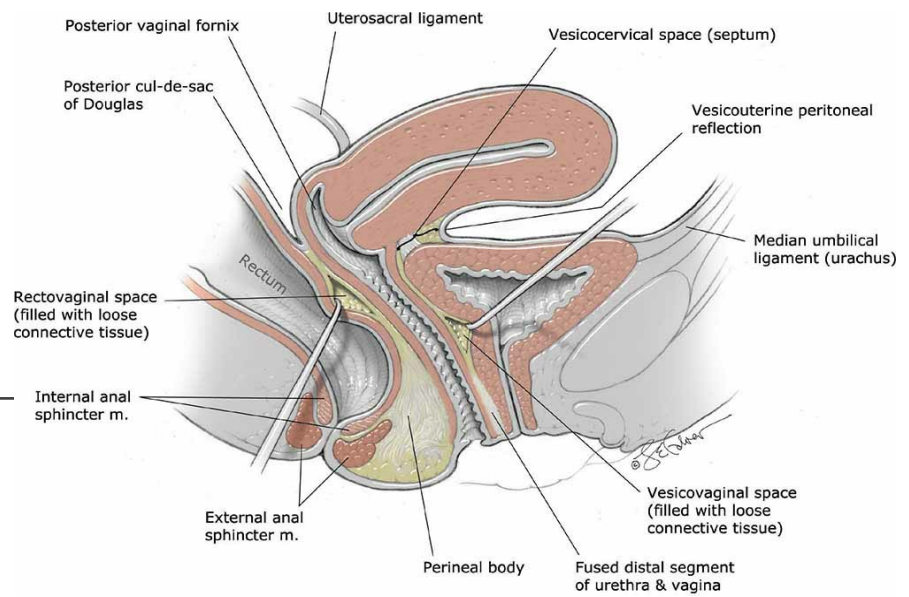
It is composed mainly of elastic and collagenous connective tissue, and both outer and inner surfaces are covered by nonkeratinized stratified squamous epithelium.

As a rule, the hymen is torn at several sites during first coitus or use of tampons → edges of the torn tissue soon reepithelialize.

In pregnant women, the hymeneal epithelium is thick and rich in glycogen.

Over time, the hymen transforms into several nodules of various sizes, termed ***hymeneal or myrtiform caruncles.***

11.Vagina



The vagina is a musculomembranous tube that extends to the uterus and is interposed lengthwise between the bladder and the rectum

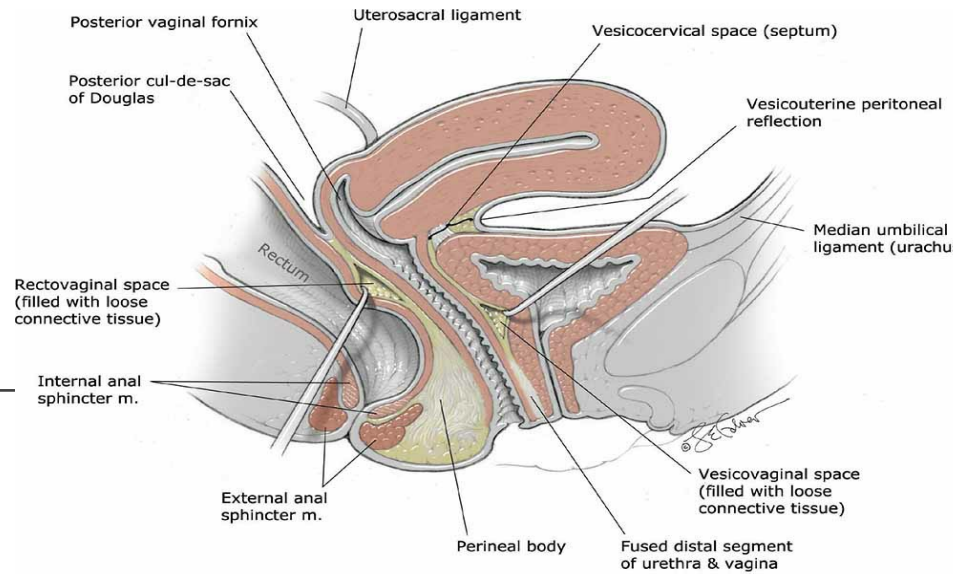
Anteriorly, the vagina is separated from the bladder and urethra by connective tissue—the vesicovaginal septum. Posteriorly, between the lower portion of the vagina and the rectum, similar tissues together form the rectovaginal septum.

The upper fourth of the vagina is separated from the rectum by the rectouterine pouch, also called the *cul-de-sac or pouch of Douglas.*

Vaginal length varies considerably, but commonly, the anterior wall measures 6 to 8 cm, whereas the posterior vaginal wall is 7 to 10 cm.

The upper end of the vaginal vault is subdivided by the cervix into anterior, posterior, and two lateral fornices. Clinically, the internal pelvic organs usually can be palpated through the thin walls of these fornices.

11.Vagina



The vaginal lining is composed of nonkeratinized stratified squamous epithelium and underlying lamina propria.

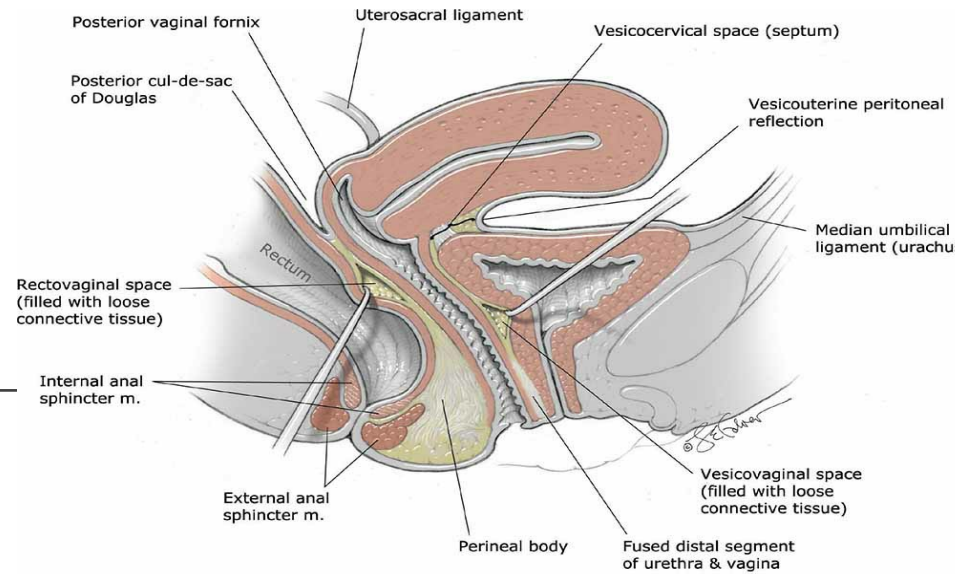
In premenopausal women, this lining is thrown into numerous thin transverse ridges, known as ***rugae***, which line the anterior and posterior vaginal walls along their length.

Deep to this, a muscular layer contains smooth muscle, collagen, and elastin. Beneath this muscularis lies an adventitial layer consisting of collagen and elastin

The vagina lacks glands → Instead, it is lubricated by a transudate that originates from the vaginal subepithelial capillary plexus and crosses the permeable epithelium

Due to increased vascularity during pregnancy, vaginal secretions are notably increased → may be confused with amnionic fluid leakage

11.Vagina



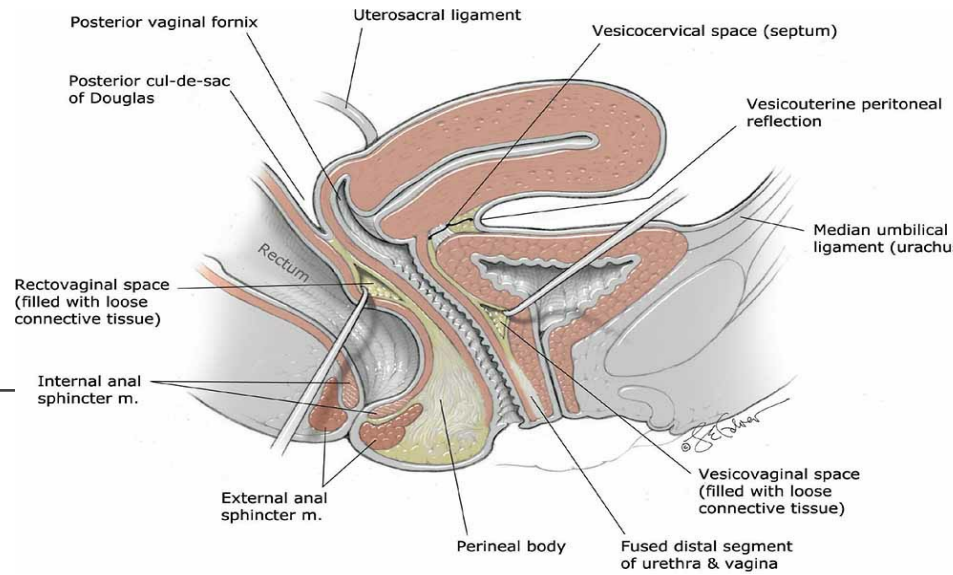
After birth-related epithelial trauma and healing, fragments of stratified epithelium are embedded beneath the vaginal surface → this buried epithelium continues to shed degenerated cells and keratin. As a result, ***epidermal inclusion cysts***, which are filled with keratin debris, may form.

The vagina has an abundant vascular supply:

- the proximal portion is supplied by the cervical branch of the uterine artery and by the vaginal artery. The latter may variably arise from the uterine or inferior vesical artery or directly from the internal iliac artery.
- The middle rectal artery contributes blood supply to the posterior vaginal wall
- distal walls receive blood supply from the internal pudendal artery.

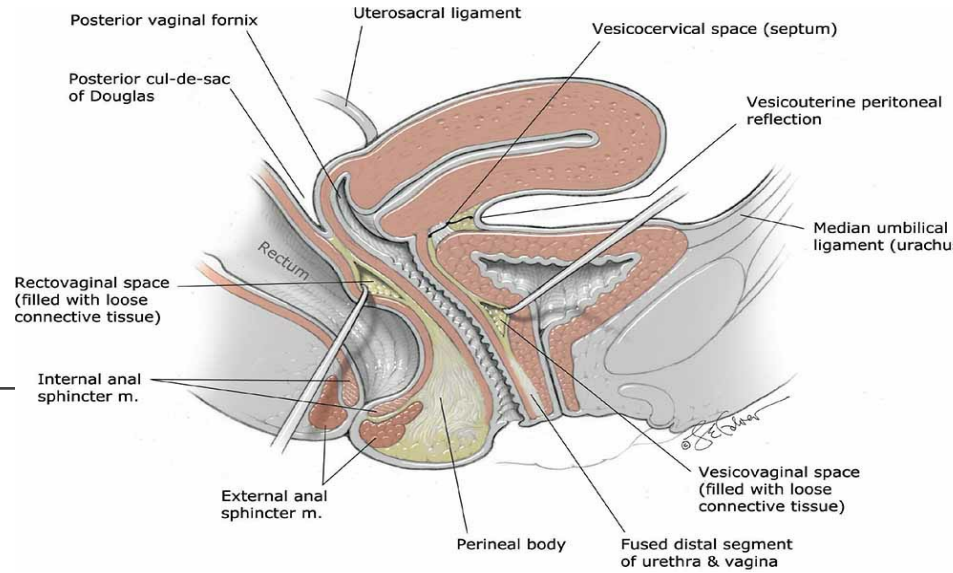
(vessels supplying each side of the vagina course medially across the anterior or posterior vaginal wall and form midline anastomoses.)

11.Vagina



- An extensive venous plexus also surrounds the vagina and follows the course of the arteries.
- Lymphatics:
  - from the lower third, along with those of the vulva, drain primarily into the inguinal lymph nodes.
  - Those from the middle third drain into the internal iliac nodes
  - Those from the upper third drain into the external, internal, and common iliac nodes.

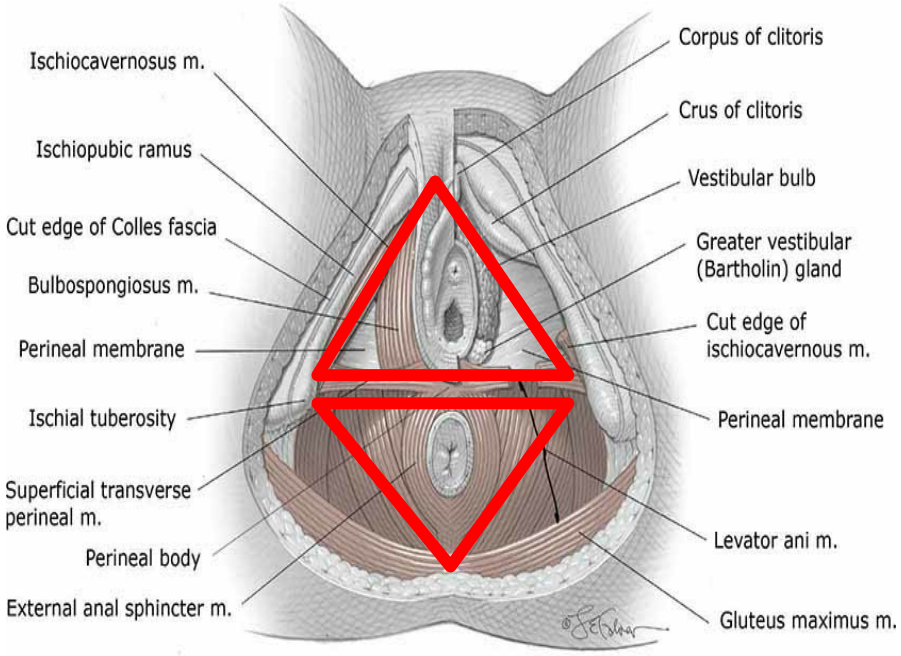
11.Vagina



- Because of the low density of nerve endings in the upper two thirds of the vagina, women are sometimes unable to determine the presence of a foreign body in this area
  - This explains how a “forgotten tampon” may remain unnoticed for several days in the upper part of the vagina until its presence results in a symptomatic discharge, abnormal bleeding, or odor.

Perineum

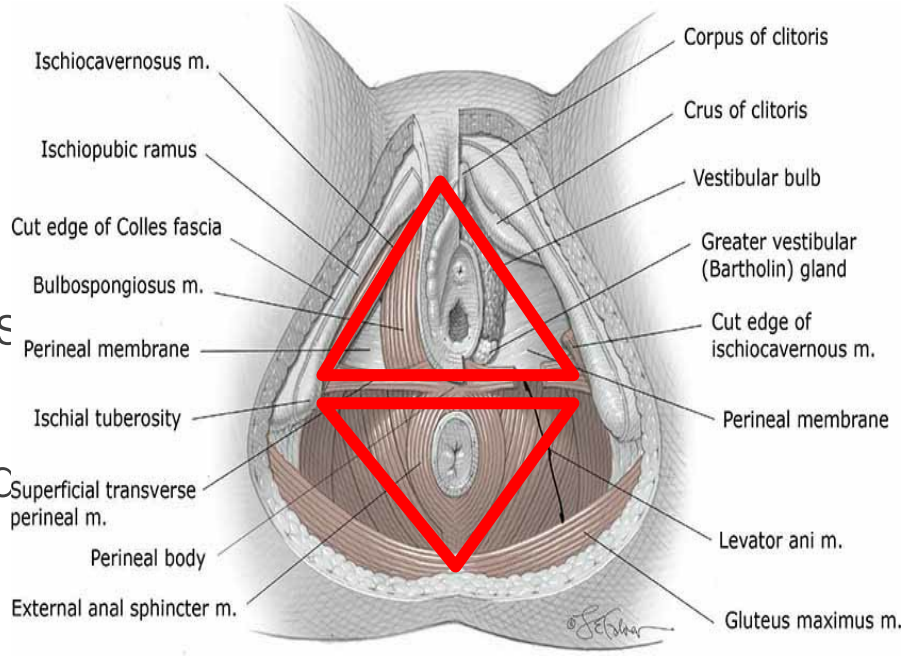
- This diamond-shaped area between the thighs
- Boundaries: the pubic symphysis anteriorly, ischiopubic rami and ischial tuberosities anterolaterally, sacrotuberous ligaments posterolaterally, and coccyx posteriorly.
- An arbitrary line joining the ischial tuberosities divides the perineum into an anterior triangle, also called the urogenital triangle, and a posterior triangle, termed the *anal triangle.*



Perineum

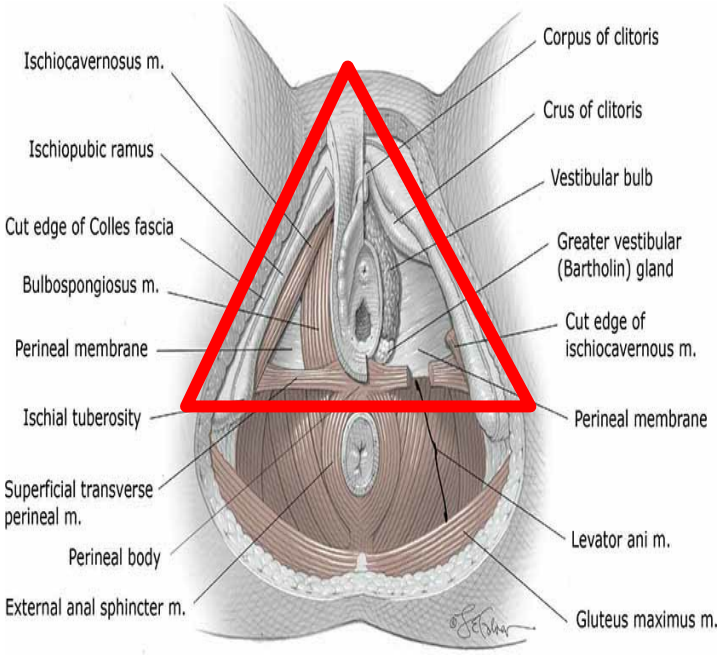
The *perineal body* is a fibromuscular pyramidal mass found in the midline at the junction between these anterior and posterior triangles

- Also called the *central tendon of the perineum*
- serves as the junction for several structures and provides significant perineal support
- the bulbospongiosus, superficial transverse perineal, and external anal sphincter muscles converge on the perineal body.
- The perineal body is incised by an episiotomy incision and is torn with second-, third-, and fourth-degree lacerations.



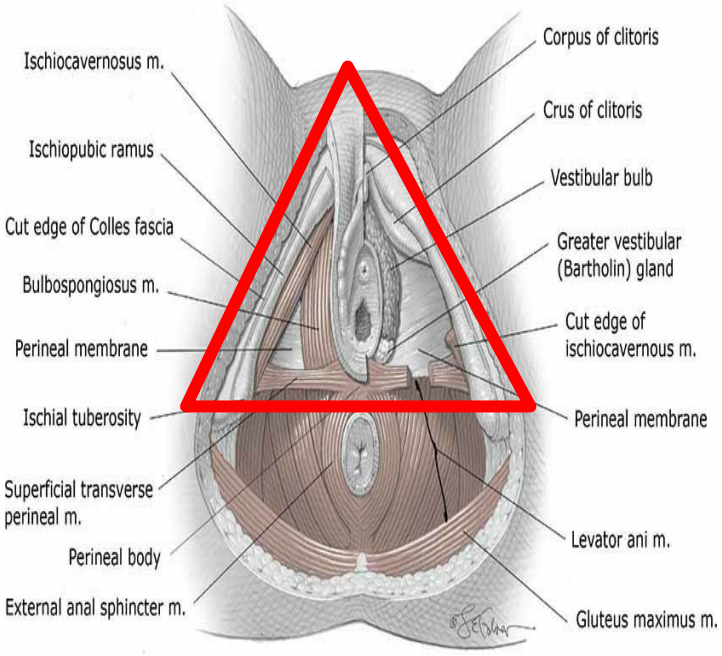
Superficial Space of the Anterior Triangle

- This triangle is bounded by the pubic rami superiorly, the ischial tuberosities laterally, and the superficial transverse perineal muscles posteriorly.
- It is divided into superficial and deep spaces by the perineal membrane → This membranous partition is a dense fibrous sheet that was previously known as the *inferior fascia of the urogenital diaphragm*.
- The perineal membrane attaches laterally to the ischiopubic rami, medially to the distal third of the urethra and vagina, posteriorly to the perineal body, and anteriorly to the arcuate ligament of the pubis



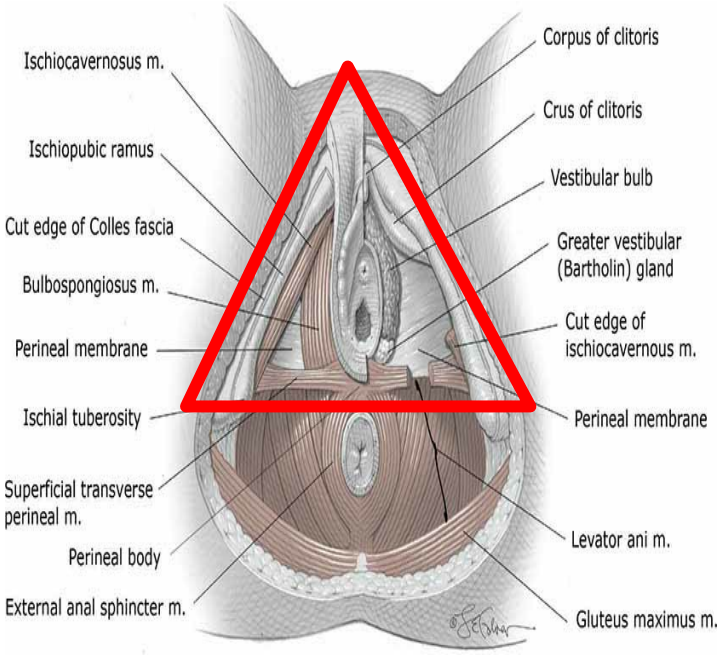
Superficial Space of the Anterior Triangle

- The superficial space of the anterior triangle is bounded deeply by the perineal membrane and superficially by Colles fascia. (*Colles fascia* is the continuation of Scarpa fascia onto the perineum)
- On the perineum, Colles fascia securely attaches laterally to the pubic rami and fascia lata of the thigh, inferiorly to the superficial transverse perineal muscle and inferior border of the perineal membrane, and medially to the urethra, clitoris, and vagina.
- As such, the superficial space of the anterior triangle is a relatively closed compartment.



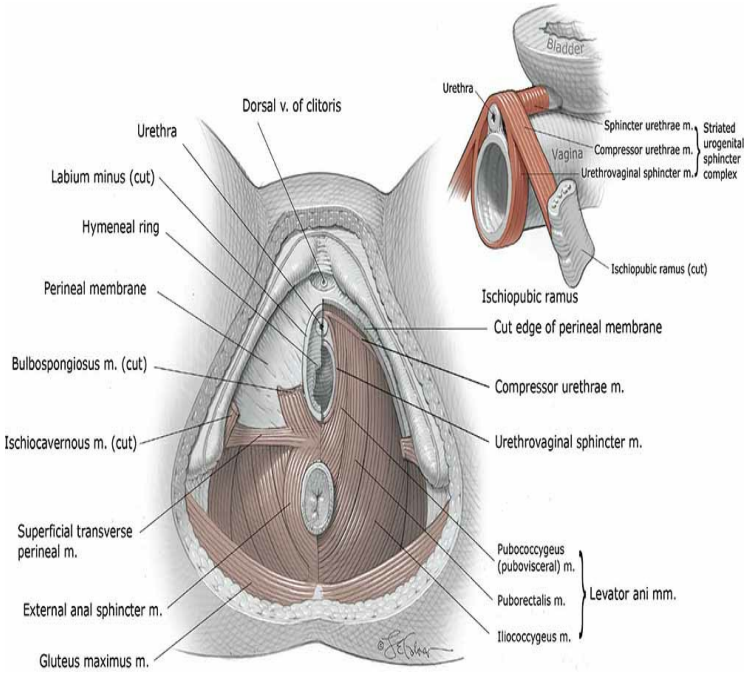
Superficial Space of the Anterior Triangle

- This superficial pouch contains several important structures: the Bartholin glands, vestibular bulbs, clitoral body and crura, branches of the pudendal vessels and nerve, and the ischiocavernosus, bulbospongiosus, and superficial transverse perineal muscles.



Deep Space of the Anterior Triangle

- This space lies deep to the perineal membrane and extends up into the pelvis
- In contrast to the superficial perineal space, the deep space is continuous superiorly with the pelvic cavity
- It contains portions of urethra and vagina, certain portions of internal pudendal artery branches, and muscles of the striated urogenital sphincter complex



Urethra

- The female urethra measures 3 to 4 cm and originates within the bladder trigone
- The walls of the urethra consist of two layers of smooth muscle, an inner longitudinal and an outer circular. This is in turn surrounded by a circular layer of skeletal muscle referred to as the *sphincter urethrae or rhabdosphincter*
- Approximately at the junction of the middle and lower third of the urethra, and just above or deep to the perineal membrane, two strap skeletal muscles called the *urethrovaginal sphincter and compressor urethrae* are found. Together with the sphincter urethrae, these constitute the *striated urogenital sphincter complex* → supplies constant tonus and provides emergency reflex contraction to sustain continence.
- blood supply: from branches of the inferior vesical, vaginal, or internal pudendal arteries.
- The pudendal nerve is believed to innervate the most distal part of the striated urogenital sphincter complex.
- Somatic efferent branches from S2–S4 that course along the inferior hypogastric plexus variably innervate the sphincter urethrae.

Pelvic Diaphragm

- Found deep to the anterior and posterior triangles, this broad muscular sling provides substantial support to the pelvic viscera.
- composed of the ***levator ani and the coccygeus muscles.***
- The levator ani contains the *pubococcygeus, puborectalis, and iliococcygeus muscles.*
- The pubococcygeus muscle is also termed the pubovisceral muscle and is subdivided based on points of insertion and function. These include the pubovaginalis, puboperinealis, and puboanalis muscles, which insert into the vagina, perineal body, and anus, respectively
- Vaginal birth conveys significant risk for damage to the levator ani or to its innervation
- levator ani avulsion may predispose women to greater risk of pelvic organ prolapse

Posterior Triangle

This triangle contains the ischioanal fossae, anal canal, and *anal sphincter complex*, which consists of the *internal anal sphincter, external anal sphincter, and puborectalis muscle*.

Branches of the pudendal nerve and internal pudendal vessels are also found within this triangle.

Ischioanal Fossae (ischiorectal fossae)

- two fat-filled wedge- shaped spaces found on either side of the anal canal and form the bulk of the posterior triangle
- Each fossa has skin as its superficial base, whereas its deep apex is formed by the junction of the levator ani and obturator internus muscles.
- Other borders: laterally, the obturator internus muscle fascia and ischial tuberosity; inferomedially, the anal canal and sphincter complex; superomedially, the inferior fascia of the downwardly sloping levator ani; posteriorly, the gluteus maximus muscle and sacrotuberous ligament; and anteriorly, the inferior border of the anterior triangle.

Posterior Triangle: Ischioanal Fossae

- The fat found within each fossa provides support to surrounding organs yet allows rectal distention during defecation and vaginal stretching during delivery.
- Clinically, injury to vessels in the posterior triangle can lead to hematoma formation in the ischioanal fossa, and the potential for large accumulation in these easily distensible spaces.
- Moreover, the two fossae communicate dorsally, behind the anal canal. This can be especially important because an episiotomy infection or hematoma may extend from one fossa into the other.

Posterior Triangle: Anal canal

This distal continuation of the rectum begins at the level of levator ani attachment to the rectum and ends at the anal skin.

Along this 4- to 5-cm length, the mucosa consists of columnar epithelium in the uppermost portion.

However, at the pectinate line, also termed *dentate line*, simple stratified squamous epithelium begins and continues to the anal verge. At the verge, keratin and skin adnexa join the squamous epithelium.

The anal canal has several tissue layers :

- Inner layers include the anal mucosa, the internal anal sphincter, and an intersphincteric space that contains continuation of the rectum's longitudinal smooth muscle layer.
- An outer layer contains the puborectalis muscle as its cephalad component and the external anal sphincter caudally.

Posterior Triangle: Anal canal

Within the anal canal, three highly vascularized submucosal arteriovenous plexuses, termed *anal cushions*, aid complete closure of the canal and fecal continence when apposed.

- Increasing uterine size, excessive straining, and hard stool create increased pressure that leads to degeneration and subsequent laxity of the cushion's supportive connective tissue base.
- These cushions then protrude into and downward through the anal canal. → This leads to venous engorgement within the cushions—now termed hemorrhoids. Venous stasis results in inflammation, erosion of the cushion's epithelium, and then bleeding.

External hemorrhoids are those that arise distal to the pectinate line → covered by stratified squamous epithelium and receive sensory innervation from the inferior rectal nerve. Accordingly, pain and a palpable mass are typical complaints.

In contrast, internal hemorrhoids are those that form above the pectinate line and are covered by insensitive anorectal mucosa → may prolapse or bleed but rarely become painful unless they undergo thrombosis or necrosis.

Posterior Triangle: Anal Sphincter Complex

Two sphincters surround the anal canal to provide fecal continence—*the external and internal anal sphincters*. Both lie near the vagina and may be torn during vaginal delivery.

The internal anal sphincter (IAS) is a distal continuation of the rectal circular smooth muscle layer.

- It receives predominantly parasympathetic fibers, which pass through the pelvic splanchnic nerves.
- Along its length, this sphincter is supplied by the superior, middle, and inferior rectal arteries.
- The IAS contributes the bulk of anal canal resting pressure for fecal continence and relaxes prior to defecation.
- it overlaps the external sphincter for 1 to 2 cm.
- The distal site at which this overlap ends, called the *intersphincteric groove*, is palpable on digital examination.

Posterior Triangle: Anal Sphincter Complex

External anal sphincter (EAS) is a striated muscle ring that anteriorly attaches to the perineal body and posteriorly connects to the coccyx via the anococcygeal ligament.

- The EAS maintains a constant resting contraction to aid continence, provides additional squeeze pressure when continence is threatened, yet relaxes for defecation.
- The external sphincter receives blood supply from the inferior rectal artery, which is a branch of the internal pudendal artery.
- Somatic motor fibers from the inferior rectal branch of the pudendal nerve supply innervation.
- Clinically, the IAS and EAS may be involved in third- and fourth- degree lacerations during vaginal delivery, and reunion of these rings is integral to defect repair

Pudendal Nerve

- This is formed from the anterior rami of S2–4 spinal nerves. It courses between the piriformis and coccygeus muscles and exits through the greater sciatic foramen at a location posterior to the sacrospinous ligament and just medial to the ischial spine
- Thus, when injecting local anesthetic for a pudendal nerve block, the ischial spine serves an identifiable landmark
- The pudendal nerve then runs beneath the sacrospinous ligament and above the sacrotuberous ligament as it reenters the lesser sciatic foramen to course along the obturator internus muscle.

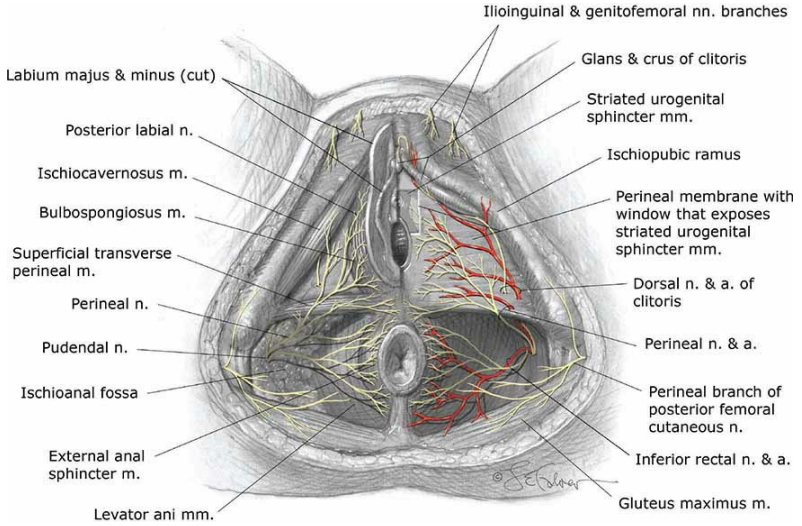


FIGURE 2-8 Pudendal nerve and vessels. (Reproduced with permission from Corton MM: Anatomy. In Hoffman BL, Schorge JO, Bradshaw KD, et al (eds): Williams Gynecology, 3rd ed. New York, McGraw-Hill Education, 2016.)

Pudendal Nerve

- Atop this muscle, the nerve lies within the pudendal canal, also known as Alcock canal, which is formed by splitting of the obturator internus investing fascia
- In general, the pudendal nerve is relatively fixed as it courses behind the sacrospinous ligament and within the pudendal canal.
- It may be at risk of stretch injury during downward displacement of the pelvic floor during childbirth
- The skin of the anus, clitoris, and medial and inferior aspects of the vulva is supplied primarily by distal branches of the pudendal nerve.

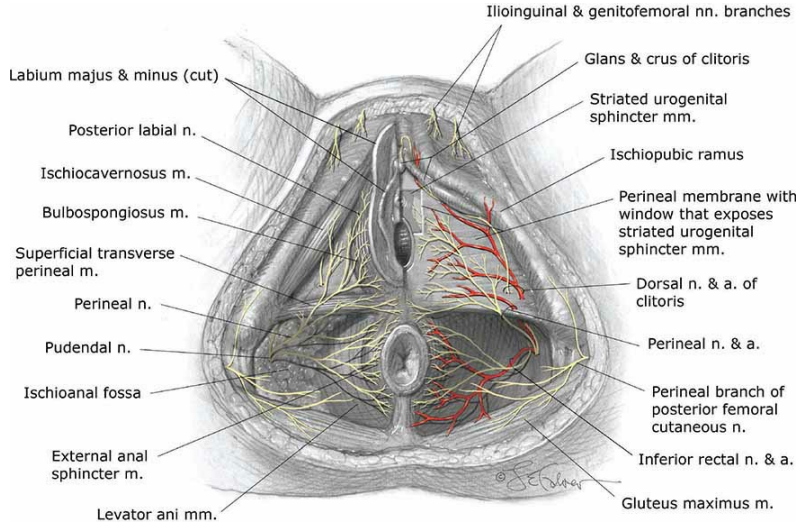


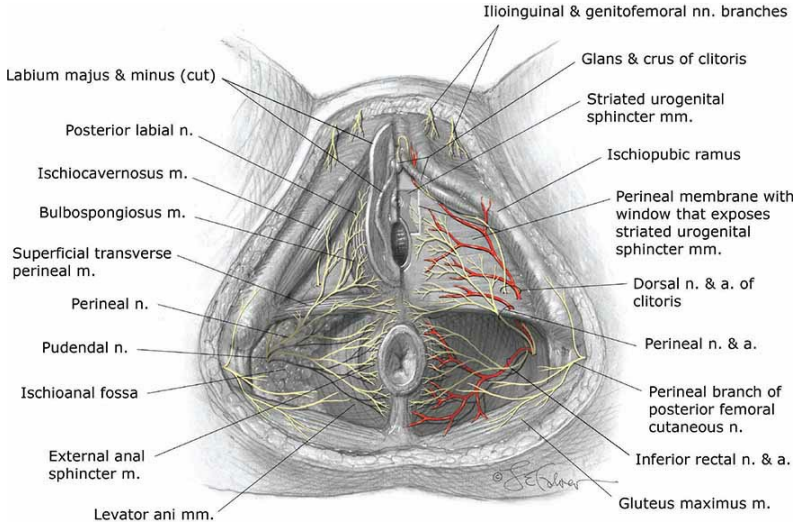
FIGURE 2-8 Pudendal nerve and vessels. (Reproduced with permission from Corton MM: Anatomy. In Hoffman BL, Schorge JO, Bradshaw KD, et al (eds): Williams Gynecology, 3rd ed. New York, McGraw-Hill Education, 2016.)

Pudendal Nerve

AS the pudendal nerve leaves Alcock canal to enter the perineum, it divides into three terminal branches

1. the dorsal nerve of the clitoris (terminal branch of the deep perineal nerve), runs between the ischiocavernosus muscle and perineal membrane to supply the clitoral glans
2. The superficial perineal nerve runs superficial to the perineal membrane→ It divides into posterior labial branches and muscular branches, which serve the labial skin and the anterior perineal triangle muscles, respectively.
3. the inferior rectal branch (inferior hemorrhoidal nerve) runs through the ischioanal fossa to supply the external anal sphincter, the anal mucosa, and the perianal skin

The major blood supply to the perineum is via the internal pudendal artery, and its branches mirror the divisions of the pudendal nerve.



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Some clinical pearls…

- Infrequent but serious complications of pudendal nerve block are hematomas from trauma to the pudendal vessels and intravascular injection of anesthetic agents. The vessels or nerves are in close anatomic proximity to the ischial spine.

- An unusual but troublesome postoperative complication of gynecologic/obstetric surgery is injury to the femoral nerve. During vaginal surgery, the femoral nerve may be injured from exaggerated hyperflexion of the legs in the lithotomy position, because hyperflexion produces stretching and compression of the femoral nerve as it courses under the inguinal ligament.

Thank you!

youtube channel: Ina Irabon

www.wordpress.com: Doc Ina OB Gyne