11. VAGINA DEVELOPMENT. FUNDUS OF THE BLADDER (f)

The sinus bulb/Müllerian eminence:

The *sinus bulb/Müllerian eminence* develops in the *posterior wall of the primitive urogenital sinus (UGS).* It divides the primitive UGS into the *vesicourethral canal abov*e, and the *definitive UGS/ vestibule below*. The sinus bulb/Müllerian eminence is mound of *mesoderm*, covered on its luminal surface by *epithelium (endoderm*) of the UGS

Sinus bulb (m):

In males the sinus bulb develops at the *upper border of the membranous urethral* segment of the vesicourethral canal and *projects upwards into the lower end of the prostatic urethral* segment of the vesicourethral canal*. The mesonephric (ejaculatory) ducts run through upper part of sinus bulb. A cylinder of condensed mesoderm (future vagina masculinus) develops in the lower part of sinus bulb.*

The lower ends of paramesonephric (Müllerian) ducts, contact the upper end of mesodermal cylinder, but do not enter the sinus bulb. In males, the paramesonephric (Müllerian) ducts, disappear, leaving a single remnant, the *appendix testis.*

Müllerian eminence (f):

The *Müllerian eminence* forms a projection in the posterior wall of the *primitive urogenital sinus (UGS)*. The *upper border of the Müllerian eminence* divides the primitive UGS into the vesicourethral canal above and definitive UGS/vestibule, below.

In females the Müllerian eminence develops at the *lower border of the membranous urethral* segment of the vesicourethral canal. It *tilts backwards* so that it lies *posterior to the membranous urethral segment of the vesicourethral canal.*

The distal ends of the mesonephric (Gartner's) ducts run vertically, through anterior part of Müllerian eminence. The mesonephric ducts run posterior to the membranous urethral segment of the vesicourethral canal, and anterior to a vertical column of condensed mesoderm. The mesonephric/Gartner's ducts diverge slightly from the midline. The openings of the ducts are anterolateral to the lower end of the column of mesoderm (future introitus of the vagina).

A *vertical cylinder of condensed mesoderm* (future vagina) develops in *the Müllerian eminence,* posterior to the distal ends of the mesonephric/Gartner's ducts.

The paramesonephric (Müllerian) ducts:
The *unfused upper segments* of paramesonephric (Müllerian) ducts, will form fallopian tubes.
The fused lower segments of paramesonephric (Müllerian) ducts will form the uterus and cervix.

The *caudal tip of the fused paramesonephric (Müllerian)* ducts, contacts the upper end of mesodermal cylinder in the Müllerian eminence, but does not enter the *Müllerian eminence.*

Müllerian eminence becomes the colliculus feminalis:

The *Müllerian eminence* can be called the *colliculus feminalis*, analogous to the *colliculus seminalis* in the male. The introitus of the vagina masculinus and openings of the ejaculatory/ mesonephric ducts on the colliculus seminalis, are analogous to the introitus of the vagina and openings of the mesonephric/Gartner's ducts anterior to the introitus of the vagina, on the *colliculus feminalis.*

The *colliculus seminalis* forms a prominent projection (from the upper border of the membranous urethra), in the posterior wall of the prostatic urethra. The *colliculus feminalis* forms a subtle projection in the roof of the posterior section of the vestibule.

DEVELOPMENT OF THE VAGINA:

The vagina develops by a process of cavitation and *canalization of a cylinder of mesoderm*, in the Müllerian eminence, posterior to the mesonephric/Gartner's ducts.

The *fused paramesonephric (Müllerian) ducts*, run *posterior to the vesicourethral canal*. The tip of the *fused paramesonephric ducts enters the upper end of the mesonephric cylinder*, but does not pass through, the Müllerian eminence.

The mesonephric/Gartner's ducts run anterior to the fused paramesonephric (Müllerian) ducts

The *cylinder of mesoderm grows upwards*, displacing the tip of the *fused paramesonephric ducts, cephalad in the pelvis.* The fused paramesonephric ducts come to lie above the level of the bladder segment of the vesicourethral canal.

In the *Müllerian eminence*, the anterior wall of the vagina, is in contact with mesoderm of the posterior wall of the membranous urethra. The *distal ends of the mesonephric/Gartner's ducts* descend in the *Müllerian eminence*, posterior to the membranous urethra, anterior to the vagina.

Above *Müllerian* eminence, the *vagina is in contact* with, the *posterior wall* of the glandular urethral segment of the vesicourethral canal. The mesonephric/Gartner's ducts descend in the glandular urethra, anterior to the vagina.

Above the glandular urethra, the *vagina is in contact with the fundus* (retroperitoneal part of the posterior wall) segment of the bladder. The mesonephric/Gartner's ducts run on the anterolateral walls of the vagina.

Upwards growth of the vagina is accompanied by *cephalad lengthening of the glandular urethra and Gartner's ducts* (in the posterior wall of the glandular urethra).

Formation of the fornices of the vagina:
The cone-shaped end *of the fused paramesonephric/Müllerian* ducts, (destined to form the vaginal part of the cervix (ectocervix) inserts in the *upper end of the cylinder of mesoderm in which the vagina is* developing. *Cavitation and canalization* of the mesodermal cylinder *around the ectocervix,* forms the *fornix of the vagina*.

The *segment of vagina around the fornices*, is *intraperitoneal,* being covered by reflections of the vesicouterine and rectouterine folds.

Intraperitoneal segment of the vagina:
A *small segment of the uppermost end of the anterior wall of the vagina*, *around the upper end of the ectocervix,* is intraperitoneal. It is *separated from* the section of the *section of the posterior wall of the bladder that is above the fundus* of the bladder, *by the vesicouterine pouch*.
*A longer segment of t*he upper end of the posterior wall *of the vagina*, around the ectocervix, is intraperitoneal. It is separated from the anterior wall of the rectum by the *rectouterine pouch of Douglas.*

The mesonephric/Gartner's ducts run on the anterolateral walls of the intraperitoneal segment of the vagina.

***Formation of the hymen and introitus of the vagina**:*
The lower end of the vagina is closed by a *bilaminar membrane.*
The *inner layer of the membrane consists of* epithelium (*differentiated from mesoderm* that lines the cavity of the vagina, on a supporting layer of nonepithelial mesoderm.

The outer layer of the bilaminar membrane consists of *epithelium/ endoderm* (on a supporting layer of mesoderm), which *covers the Müllerian eminence* and is *continuous with the lining of the urogenital sinus/vestibule*.

A perforation develops in the bilaminar membrane, which *is the introitus of the vagina*. The *bilaminar membrane is now a bilaminar ring around the introitus, which is the hymen* of the vagina.

Vestiges of the mesonephric ducts (f).
The mesonephric/Gartner's ducts largely disappear in females. Remnants may persist as the duct of the *paroöphoron*, in the broad ligament, small segments in the anterolateral wall of the uterus, and upper vagina, may present as *Gartner's duct cyst*. A *thin tubular segment in the glandular urethra*, is a Gartner's duct, rather than a Skene's duct. *Tiny openings of Gartner's ducts* may persist anterior to the introitus of the vagina, just posterior to the membranous urethra. A *paraurethral cyst*, lateral to the distal urethral orifice, is a Gartner's duct cyst, rather than a Skene duct cyst.

***Vesicouterine fold of peritoneum:** (f).*
The vesicouterine fold, is a fold of peritoneum that reflects from the *posterior wall of the bladder*, that is above the fundus of the bladder, to the *anterior wall of the vagina,* at the level of the dome of the fornix of the vagina. The *recess of the vesicouterine fold*, between the posterior wall of the bladder and the vagina, is called *vesicouterine pouch.*
The *uterine layer of the vesicouterine* fold spreads on the anterior surface of the supravaginal portion of the cervix, the isthmus and vesical surface of the body of the uterus.

Laterally, the posterior/uterine layer of the vesicouterine fold, is continuous with the anterior layer of the broad ligament of the uterus.

Broad ligament of the uterus:
On either side of the body of the uterus and intraperitoneal segment of the vagina, the posterior/layer of the vesicouterine fold is continuous with the *anterior layer of the broad ligament* of the uterus, and the *anterior/uterine layer of the rectouterine fold* is continuous with the *posterior layer of the broad ligament* of the uterus.

Posterior wall of the bladder:
The posterior wall of the bladder can be divided into two segments, and upper and a lower segment. The *upper segment is intraperitoneal*, covered by the vesical part of the *vesicouterine fold*. The *lower segmen*t of the posterior wall, the *fundus or base of the bladder* is below the vesicouterine fold and is *retroperitoneal.*

Intraperitoneal segment of the posterior wall of the bladder: (f).
The *uppermost or intraperitoneal*, segment of the vagina, surrounds the vaginal part of the cervix (ectocervix) and fornices of the vagina. The *vesicouterine fold*, reflects from the posterior surface of the bladder, (above the fundus), *on the anterior wall of the upper end of the vagina*, that surrounds the ectocervix.

Fundus of the bladder: *(f).*
The *fundus or base,* of the bladder, is the triangular posterior wall of the bladder, that is entirely r*etroperitoneal*. The *base of the fundus* is the *lower border of the vesicouterine fold*. The *apex of the fundus* is the *junction of the bladder and glandular urethra*, at the level of the internal urethral orifice.
The *anterior wall of the upper/retroperitoneal segment of the vagina,* is adherent to the fundus of the bladder. Vestigial segments of Gartner's ducts, run in the anterolateral walls of the vagina, posterior to the fundus of the bladder.

Paramesonephric (Müllerian) ducts: (f).
Early in development the *fused segments of the paramesonephric ducts* (future body of the *uterus and the cervix*), descend *posterior* to the bladder segment, and glandular segment, of the *vesicourethral canal.*
The distal ends of the fused paramesonephric ducts contact the upper end of the cylinder of condensed mesoderm (future vagina), in the Müllerian eminence, posterior to the membranous urethral segment of the vesicourethral canal. Upwards growth of the developing vagina displaces the fused paramesonephric ducts upwards into the pelvis.
Later in development, the vagina (not the paramesonephric ducts) is in contact with the membranous urethra, glandular urethra, and fundus of the bladder.

Mesonephric (Gartner's) ducts: (f).
The *mesonephric (Gartner's) ducts, run* on either side of the midline in the anterolateral walls of the fused paramesonephric ducts.
Behind the fundus of the bladder, the ducts descend in the anterolateral walls of the vagina.

The posterior wall of the glandular and membranous urethra is adherent/embedded in the anterior wall of the vagina. Gartner's ducts run in the posterior wall of the glandular urethra.

At the apex of the fundus of the bladder, (internal urethral orifice), Gartner's ducts leave the anterolateral walls of the vagina, and descend in the *posterior wall of the glandular urethra*.
At the lower end of the glandular urethra, the terminal ends of Gartner's ducts, descent posterior to the membranous urethra, in the colliculus feminalis.
Gartner's ducts open on colliculus feminalis, posterior to the distal urethral orifice of the membranous urethra, and anterior to the introitus of the vagina.

Roof of the vestibule:
The Müllerian eminence/*colliculus feminalis develops posterior to the membranous urethra*.
The *roof of the vestibule* is formed by the *colliculus feminalis and the distal urethral orifice* of the membranous urethra. The *colliculus feminalis* contains the introitus and hymen of the *vagina* and the *openings of Gartner's ducts.*

Openings in the roof of the vestibule:

The lower end of the vagina, distal ends of Gartner's ducts and the membranous urethra, pierce the perineal membrane and open in the roof of the vestibule.

Openings in the roof of the vestibule:

a) introitus of the vagina
b) openings of Gartner's ducts
c) distal urethral orifice (of the membranous urethra)

Epithelium of the Müllerian eminence:

The *Müllerian eminence* consists of a *tubercle of mesoderm*, in the posterior wall of the urogenital sinus/vestibule, covered by a layer of epithelium derived from endoderm of the urogenital sinus/vestibule

Epithelium of the roof and walls of the vestibule:

a) Epithelium lining the *roof and walls of the vestibule*, is derived from endoderm, of the definitive urogenital sinus.
b) Epithelium of the *outer layer of the hymen*, is derived from *endoderm covering the Müllerian eminence.*
c) Epithelium surrounding the openings of Gartner's ducts, is derived from *mesoderm of the walls of the mesonephric/Gartner's ducts.*
d) Epithelium of the *trigone of the colliculus feminalis*, between the openings of the Gartner's ducts and external urethral orifice, is differentiated from the lumenal surface of *mesoderm of the trigone of the colliculus feminalis, and urethral crest* in the membranous urethra.
e) Epithelium around the external urethral meatus, is derived from *mesoderm of the wall of the membranous urethral segment of the vesicourethral canal*

The vagina and Gartner's ducts open on the colliculus feminalis, in the roof of the *posterior section of the vestibule.*
The *distal urethral orifice of the membranous urethra* opens in the roof of the *middle section of the vestibule*.
The anterior section of the vestibule forms a flat mucosal roof, on the ventral aspect of the clitoris.

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