20. MALE FEMALE GENITAL HOMOLOGUES

Introduction

Urorectal septum divides hindgut into dorsal anorectum and ventral primitive urogenital sinus (UGS)

Sinus bulb/Müllerian eminence forms eminence on posterior wall of primitive UGS.
(m) Upper border of sinus bulb, divides primitive UGS into vesicourethral canal above and definitive UGS/vestibule below. Membranous urethra develops from vesicourethral canal. Functionally, membranous urethra, belongs to vestibule/urethra.
(f) Lower border of Müllerian eminence, divides primitive UGS into vesicourethral canal above and definitive UGS/vestibule below. Membranous urethra anatomically and functionally, belongs to vesicourethral canal.

(m) The definitive UGS/vestibule/urethra extends on the ventral aspect of the genital swelling (penis), as the phallic part of the vestibule/urethra.
(f) The definitive UGS/vestibule, extends of the ventral aspect of the genital swelling (clitoris) as the anterior section of the vestibule

Male	**Female**	**Origin**
Allantois/urachus, bladder, prostatic urethra, membranous urethra	Allantois/urachus, bladder, glandular urethra, membranous urethra	Vesicourethral canal
Membranous urethra joins bulbar urethra, penile urethra, and fossa navicularis.	Membranous urethra, Gartner's ducts, vagina, open in definitive urogenital sinus/ vestibule.	Bulbar urethra, penile urethra, and fossa navicularis, from definitive UGS/vestibule.
Colliculus seminalis (CS)	Colliculus feminalis (CF)	Sinus bulb/Müllerian tubercle
CS develops from upper border of membranous urethra, projects into prostatic urethra	CF develops distal then posterior to membranous urethra	
Mesonephric (Wolffian) ducts develop vas deferens, seminal vesicles, ureteric buds (and collecting system of kidneys), and ejaculatory ducts,	Mesonephric (Gartner's) ducts develop ureteric buds, and collecting system of kidneys	
Distal ends of ejaculatory ducts run through CS, vagina masculinus develops in CS	Distal ends of Gartner's ducts run through CF. Vagina begins development in CF.	Gartner's ducts, atretic remnants of mesonephric ducts.
Distal to ducts of seminal vesicle, ejaculatory ducts enter upper end of prostatic urethra	Lower segments of Gartner's ducts, enter upper end of glandular urethra.	
Distal ends of ejaculatory ducts enter CS anterolateral to vagina masculinus	Distal ends of Gartner's ducts enter CF anterior to vagina	
Vagina masculinus develops in cylinder of mesoderm in CS	Lower end of vagina in CF develops in cylinder of mesoderm in CF. Vagina grows upwards, behind glandular urethra and fundus of bladder.	Lumen of vagina masculinus (m) and vagina (f) develops by cavitation of cylinder of mesoderm in sinus bulb/ Müllerian eminence. Cavitation may be induced by distal end of paramesonephric ducts?
		Duplicated (unfused) paramesonephric ducts may induce duplicate vagina with longitudinal septum

Male	Female	Origin
CS arises from posterior border of upper end of membranous urethra. Forms prominent projection, oriented vertically in lower end of prostatic urethra.	CF develops posterior to membranous urethra. Forms subtle elevations, oriented horizontally, in posterior section of vestibule.	Glandular urethra and Gartner's ducts grow cephalad from upper end of CF.
Convex upper border of CS continuous w upper border of membranous urethra.	Lower border of CF level with opening of membranous urethra.	
Ejaculatory ducts enter upper end prostatic urethra, descend in parallel, behind urethral crest. Posterior to lower end of prostatic urethra, ejaculatory ducts, run through CS, diverge slightly from the midline and open on CS, in lower end of the prostatic urethra.	Gartner's ducts leave anterolateral wall upper 1/3rd of vagina, enter upper end of glandular urethra, descend in parallel, behind urethral crest of glandular urethra. Posterior to membranous urethra. Gartner's ducts descend through CF, posterior to urethral crest of membranous urethra, diverge slightly from the midline and open on CF posterior to external urethral orifice of the membranous urethra.	
In CS, ejaculatory ducts run antero-lateral to vagina masculinus.	In CF, Gartner's ducts run anterolateral to lower end of vagina.	
Ejaculatory ducts open on CS, anterolateral to introitus of vagina masculinus, in lower end of prostatic urethra.	Gartner's ducts open on CF, anterior to introitus of vagina, in posterior section of vestibule.	
Hymen of vagina masculinus: Diaphanous membrane, at lower end of vagina masculinus.	Hymen of vagina: Membrane at lower end of vagina.	Inner layer: Epithelium (mesoderm), on thin layer of mesenchyme, from lining of vagina. Outer layer: Epithelium (endoderm), from sinus bulb/Müllerian tubercle.
Introitus of vagina masculinus: Perforation in hymen of vagina masculinus. Opens on CS, inferior to openings of ejaculatory ducts.	Introitus of vagina: Perforation in hymen of vagina. Opens on CF, posterior to openings of Gartner's ducts.	
Membranous urethra, terminal segment of vesicourethral canal, joins bulbar urethra. Functions as pelvic part of vestibule.	Membranous, terminal part of vesicourethral canal. Opens in middle section of vestibule.	
Structures that pierce (inferior) perineal membrane: Membranous urethra pierces perineal membrane, to join bulbar urethra.	Structures that pierce (inferior) perineal membrane: Distal end of vagina, Gartner's ducts pierce perineal membrane, to open in roof of posterior section of vestibule. Membranous urethra pierces perineal membrane, to open in middle section of vestibule	

Male	**Female**	**Origin**
Vestibule/urethra	Vestibule	Definitive urogenital sinus (UGS)
Vestibule is <u>distal to upper border</u> colliculus seminalis (CS).	Vestibule is <u>below lower border</u> of colliculus feminalis (CF).	CS develops in posterior wall of UGS at upper border of membranous urethra (m). CF appears in posterior wall of UGS below membranous urethra, and tilts posterior to membranous urethra (f).
Segments male vestibule/urethra: *Pelvic part:* membranous urethra. *Perineal part:* bulbar urethra, (proximal to suspensory ligament penis (SLP). *Phallic part:* penile urethra, fossa navicularis, (ventral to bicavernosal body of penis).		Sections of female vestibule: *Posterior section:* below CF with openings of introitus of vagina, openings of Gartner's ducts). *Middle section:* below distal urethral orifice of membranous urethra, (posterior to suspensory ligament of clitoris (SLC). *Anterior (phallic) section:* distal to SLC, (ventral to pars intermedia, ventral to dorsal hood of clitoris, ventral to roof and cap of glans clitoris).
Bulbar urethra		Postero-anterior ventral midline fusion definitive urogenital sinus/vestibule in perineum (m).
	Posterior section of definitive UGS/vestibule below introitus of vagina, and openings of Gartner's ducts, on colliculus feminalis (CF).	Open definitive urogenital sinus/vestibule (f).
Corpus spongiosum of bulbar urethra: Spongy cylindrical body, surrounds bulbar urethra. Expansion posterior to bulbar urethra, forms bulb of corpus spongiosum		Postero-anterior, dorsal, and ventral fusion of vestibular bulbs surrounds bulbar urethra. Bulbs unite behind bulbar urethra. Continues as corpus spongiosum of penile urethra in phallus.
	Bulbs of vestibule: Narrow elongated spongy bodies on lateral walls of posterior and middle sections of vestibule.	Bulbs of vestibule, develop on sides of definitive UGS/vestibule. Bulbs unite anteriorly to form *pars intermedia*
Bulbocavernosus muscles: Pair of flat muscles joined by median raphe; covers ventral and lateral aspect and posterior aspects of corpus spongiosum of bulbar urethra. Origin: median raphe and central tendon of perineum, and perineal membrane, lateral and posterior to corpus spongiosum. Insert with ischiocavernosus muscles in the dorsal aspect of the proximal end of the tunica albuginea of bicavernosal body penis		Bulbocavernosus muscles: Pair of flat muscles cover the lateral, ventral, and posterior aspects of the vestibular bulbs. Origin: perineal membrane and central tendon of perineum, lateral and posterior to vestibular bulbs. Insert with ischiocavernosus muscles into the dorsal aspect of the proximal end of the tunica albuginea of bicavernosal body clitoris
Corpora cavernosa of penis: Pair of cylindrical erectile bodies of the penis. a) Crura of corpora cavernosa. Tapered posterior ends of corpora cavernosa, attached to everted medial surface of the inner aspect of ischiopubic rami. Crura leave ischiopubic rami, acquire a dense fibrous envelope, called tunica albuginea, to form cavernosal bodies. Medial aspects of the cavernosal bodies (tunica albuginea) fuse in midline under arcuate ligament of the pubis, to form the bicavernosal body of the penis. b) Bicavernosal body of the penis, enters phallus/penis at level of suspensory ligament of the penis. Fused medial aspects of tunica albuginea of bicavernosal body form a perforated septum of the bicavernosal body. Blood can flow freely between the cavernosal bodies. Ventral aspect of tunica albuginea of the bicavernosal body presents a groove, to which is attached (tunica albuginea of) corpus spongiosum of the penile urethra and dorsal plate of fossa navicularis. The cone-shaped distal end of the bicavernosal body, inserts in the crescentic cap of the glans penis.	
Corpora cavernosa of clitoris: Pair of cylindrical erectile bodies of the clitoris. a) Crura of corpora cavernosa. Tapered posterior ends of corpora cavernosa, attached to everted medial surface of the inner aspect of ischiopubic rami. Crura leave ischiopubic rami, acquire a dense fibrous envelope, called tunica albuginea, to form cavernosal bodies. Medial aspects of the cavernosal bodies (tunica albuginea) fuse in midline under arcuate ligament of the pubis, to form the bicavernosal body of the clitoris. b) Bicavernosal body of clitoris, enters phallus/clitoris at level of suspensory ligament of the clitoris. Fused medial aspects of tunica albuginea of bicavernosal body form a perforated septum of the bicavernosal body. Blood can flow freely between the cavernosal bodies. Ventral aspect of tunica albuginea of the bicavernosal body presents a groove, to which is attached the (tunica albuginea of) pars intermedia. The cone-shaped distal end of the bicavernosal body, inserts in the crescentic cap of the glans clitoris.	

Male	Female	Origin
Ischiocavernosus muscles: Pair of flat muscles over the crura of the corpora cavernosa. (m), (f). Origin: Ischiopubic rami on the sides of the attached crura of the corpora cavernosal bodies. Insert with bulbocavernosus muscles on dorsal aspect of proximal end of the tunica albuginea of bicavernosal body of the penis or clitoris.		
Scrotal sacs		Scrotal folds (m).
	Labia majora	(Unfused) labial folds (f).
Scrotal septum		Medial aspects of scrotal folds (mesoderm) fuse in the midline (m).
Scrotal raphe		Fusion of vestibular/urethral folds ventral to bulbar urethra. Scrotal septum distances bulbar raphe from bulbar urethra. Bulbar raphe named scrotal raphe (m).
	Labia minora ventral to posterior and middle sections of vestibule	Unfused vestibular/labial folds (f).
Posterior end of scrotal raphe, joins anterior end of perineal (anogenital) raphe	Posterior commissure of labia minora (fourchette), joins end of perineal (anogenital) raphe	
(Median) perineal (anogenital) raphe, joins anal verge to posterior end of scrotal raphe	(Median) perineal (anogenital) raphe, joins anal verge to posterior commissure of labia minora (fourchette).	Perineal (anogenital) raphe formed by median fusion of perineal plates
Anterior end of scrotal raphe, joins posterior end of penile raphe	Anterior ends of vestibular/ labial folds, join vestibular/ labial folds (frenulum) clitoris	
Penile raphe	N/A	Midline fusion of vestibular/urethral folds, ventral to penile urethra, proximal to coronal sulcus. Outer borders of penile raphe reflect on epithelium (genital fold) of the penis
Preputial raphe	N/A	Continuation of penile raphe on outer and inner folds of prepuce
Frenulum of coronal sulcus	N/A	Midline fusion of vestibular/urethral folds, ventral to penile urethra, in coronal sulcus. Outer layers of frenulum reflect on epithelium (genital fold) of the coronal sulcus.
Navicular raphe		Fused vestibular/urethral folds ventral to fossa navicularis (m).
	Frenulum of clitoris	(Unfused) labia minora ventral to anterior section of vestibule (f).
	Anterior section of vestibule is ventral to dorsal hood of clitoris, and ventral to pars intermedia	
	Tunica albuginea on dorsal surface of pars intermedia, adheres to groove of tunica albuginea on ventral aspect of bicavernosal body of clitoris	
	Bicavernosal body in the clitoris, is enclosed by dorsal hood of clitoris, and roof and cap of clitoris (covered by epithelium from genital fold).	
	Flat mucosal roof ventral to pars intermedia. Tunica albuginea on dorsal aspect of pars intermedia adheres to groove of tunica albuginea on ventral aspect of bicavernosal body of clitoris.	
	Outer borders of labia minora/frenulum (ectoderm), reflects on ventral borders of dorsal hood (ectoderm of genital fold), and ventral border of epithelium of roof and cap of clitoris.	

Male	Female	Origin
	Inner borders of labia minora/frenulum (ectoderm), meet lateral borders of anterior section of vestibule (endoderm), at Hart's line.	
Suspensory ligament penis (SLP)	Firm ligament formed by a) superficial fibers from linea alba of rectus abdominis (fundiform ligament), joined by b) deep fibers from the pubic symphysis. Both sets of fibers merge with deep (Buck's) fascia, which surrounds the bicavernosal body of the penis and corpus spongiosum of the penile urethra.	
Suspensory ligament clitoris (SLC)	Slender ligament formed by a) superficial fibers from the linea alba of rectus abdominis, joined by b) deep fibers from the pubic symphysis. Both sets of fibers merge with deep fascia that surrounds the bicavernosal body of the clitoris, and pars intermedia.	
Penile urethra in corpus spongiosum, is surrounded by tunica albuginea, adherent to ventral groove of tunica albuginea of the bicavernosal body of penis.		Postero-anterior ventral midline fusion of penile vestibule/urethra. Continuation of postero-anterior, dorsal, and ventral fusion of corpus spongiosum around bulbar urethra (m).
Prepuce		Genital fold.
Preputial raphe		Fused vestibular/ urethral folds
Lateral borders of preputial raphe reflect on ventral borders of outer and inner layers of prepuce		Lateral borders of fused vestibular/ urethral folds reflect on ventral borders of genital fold.
	Dorsal hood of clitoris	Genital fold. Ventral borders join outer borders of (unfused) vestibular/ labial folds
	Ventral borders of dorsal hood reflect on lateral borders of labia minora/frenulum of glans clitoris	Ventral borders of genital fold reflect on lateral borders of (unfused) vestibular/labial folds.
Coronal sulcus, space between inner layer of prepuce and glans penis	Recess between inner layer of dorsal hood and glans clitoris	
Navicular raphe, ventral to fossa navicularis.		Fused vestibular/urethral folds, ventral to fossa navicularis.
Lateral borders of navicular raphe reflect on epithelium of ventral borders of wings of the glans penis		
	Labia minora/frenulum of clitoris, ventral to anterior section of vestibule in glans clitoris	(Unfused) vestibular/labial folds ventral to anterior section of vestibule.
	Labia minora/frenulum of clitoris, unite in anterior commissure, below ventral point of crescentic cap of glans clitoris	Vestibular/labial folds unite in anterior commissure, under ventral point of crescentic cap of glans clitoris.
Lateral borders of navicular raphe reflect on epithelium of ventral borders of wings of the glans penis	Outer borders of labia minora/ frenulum and anterior commissure, reflect on epithelium of ventral borders of roof and ventral point of crescentic cap of glans clitoris	Outer borders of vestibular/labial folds and anterior commissure, reflect on ventral borders of genital fold over roof and ventral point of crescentic cap of glans clitoris
	Inner borders of labia minora/ frenulum and anterior commissure, meet mucosa at lateral edges and anterior end of flat roof of anterior section of vestibule at Hart's line	Inner layers of (unfused) vestibular/ labial folds and anterior commissure, (ectoderm), join lateral edges and anterior border, of flat mucosal roof of vestibule (endoderm), at anterior section of Hart's line
	Inner layers of vestibular/labial folds and posterior commissure/ fourchette (ectoderm), join ventral edges of posterior wall, and ventral edges of lateral walls (endoderm), to form posterior section of Hart's line wall, and ventral edges of lateral walls (endoderm), to form posterior section of Hart's line.	

Male	Female	Origin
Fossa navicularis (glanular urethra)		Postero-anterior ventral midline fusion of penile vestibule/urethra. Roof of fossa navicularis, adherent to dorsal plate of fossa navicularis.
	(Narrow mucosal roof of) anterior section of vestibule	Mucosal roof of vestibule, adherent to pars intermedia.
Dorsal plate of fossa navicularis: Dorsal surface covered by tunica albuginea adherent to ventral groove of cone-shaped tip of bicavernosal body of penis. Ventral surface of dorsal plate is adherent to roof of tubular fossa navicularis		Corpus spongiosum of penile urethra, reduced to form dorsal plate over fossa navicularis (m).
	Pars intermedia of anterior section of vestibule: Dorsal surface has covering of tunica albuginea adherent to ventral groove of cone-shaped tip of bicavernosal body of the clitoris. Ventral surface of pars intermedia adherent to flat mucosal roof of anterior section of vestibule	Vestibular bulbs unite under arcuate ligament of pubic symphysis, form pars intermedia, which passes through the suspensory ligament clitoris, to form pars intermedia over anterior section of vestibule (f).
Glans penis: cap, roof, wings.	Glans clitoris: cap, roof.	Generated by dorsal plate/pars intermedia of glans penis/clitoris, ventral to bicavernosal body of penis/clitoris.
		Dorsal plate/pars intermedia, ends just distal to tip of bicavernosal body
Crescentic cap of glans penis molded over cone-shaped tip of bicavernosal body of penis.	Crescentic cap of glans clitoris molded over cone-shaped tip of bicavernosal body of clitoris.	Cap of glans penis/clitoris generated by distal end of dorsal plate of fossa navicularis/distal end pars intermedia.
Roof of glans penis, covers dorsal and lateral aspects of bicavernosal and lateral aspect of dorsal plate of fossa navicularis	Roof of glans clitoris, covers dorsal and lateral aspects of bicavernosal body and lateral aspect of pars intermedia	Roof of glans penis/clitoris generated by outer borders of dorsal plate of fossa navicularis (m) or pars intermedia in anterior section of vestibule, distal to dorsal hood (f).
Posterior border of roof of glans penis, forms dorsal part of corona of glans penis	Posterior border of roof of glans clitoris, forms corona of glans clitoris	
Wings of glans penis drape around lateral, and ventral aspects of fossa navicularis (except in ventral midline)	N/A	Wings of glans penis, generated by (ventral surfaces of) outer borders of dorsal plate of fossa navicularis
Posterior borders of wings of glans penis (curved ventrally and distally), form coronal sulcus part of corona of glans penis	N/A	
Ventral borders of wing contact thin band of tissue between navicular raphe and floor of fossa navicularis.	N/A	
Navicular raphe joins ventral ends of labia of glans penis	N/A	Fused vestibular/urethral folds, ventral to fossa navicularis, join unfused (distal ends of) vestibular/urethral folds.
Labia of glans penis and dorsal commissure of labia of glans penis	N/A	Unfused vestibular/urethral folds and anterior commissure of vestibular/urethral folds.
Labia of glans penis and dorsal commissure of labia of glans penis, form external urethral meatus	N/A	Posterior ends of unfused vestibular/urethral folds pushed distally by distal/anterior borders of wings of glans penis, so vestibular/urethral folds and anterior commissure of the folds, align vertically, with the opening at the end of fossa navicularis

Male	Female	Origin
Dorsal commissure of labia of glans penis is attached to ventral point of crescentic cap of the glans penis, in dorsal angle of external urethral meatus	Anterior commissure of labia minora/frenulum of the glans clitoris, attached to ventral point of crescentic cap of glans clitoris, at distal end of anterior section of vestibule.	
Outer border of dorsal commissure of labia of glans penis, reflects on epithelium of ventral point of crescentic cap of glans penis, in dorsal angle of external urethral meatus	Outer border of anterior commissure of labia minora/ frenulum, reflects on epithelium of crescentic cap of glans clitoris, at distal end of anterior section of the vestibule.	
Outer borders of labia of glans penis reflect on epithelium of anterior borders of wings of glans penis.	Outer borders of labia minora/frenulum reflect on ventral borders of epithelium of roof of glans clitoris.	
Inner borders of labia of glans penis and dorsal commissure of labia of glans penis (ectoderm), meet mucosa (endoderm), at elliptical opening of fossa navicularis, at Hart's line	Inner borders, of labia minor/frenulum, and anterior commissure of labia minora/frenulum, meet mucosa (endoderm), at ventral opening of anterior section of the vestibule, at Hart's line.	

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