

TS17	10.5dpc (range 10-11.25 dpc)
TS18	11dpc (range 10.5-11.25 dpc)
TS19	11.5 dpc (range 11-12.25 dpc)
TS20	12 dpc (range 11.5 – 13 dpc)
TS21	13 dpc (range 12.5 – 14 dpc)
TS22	14 dpc (range 13.5 – 15 dpc)
TS23	15 dpc
TS24	16 dpc
TS25	17 dpc
TS26	18 dpc
TS27	newborn (range P0 - P3)
TS28	P4 – Adult

Ontology trees – **red text = new terms or modified terms**

A number of terms have been merged, with the **Alt ID** providing a reference to the secondary ID.

Genital tubercle, external genitalia and reproductive structures.

Genital tubercle (TS19)

Genital tubercle (TS19): a medial swelling seen at the level of the hind limb buds, adjacent to the cloaca and posterior/caudal to the UGS. At TS19 the genital tubercle can be subdivided into a dorsal genital swelling and two ventrolateral genital swellings, which have merged into a single genital tubercle. At TS19, is comprised of urethral plate epithelium and surface ectoderm of genital tubercle. The urethral plate epithelium and surface ectoderm together are known as the cloacal membrane. Derives from the TS17-TS18 genital swelling. From TS20, the genital tubercle becomes genital tubercle of male/female.

Urethral plate epithelium (syn: urethral plate) (TS19): a bilaminar epithelial extension of the cloacal epithelium that grows out from the cloaca, between the ventrolateral genital swellings. Derived from cloacal endoderm. This bilayered epithelium often called the urethral plate, marked by *Shh*, continues to grow distally with the genital tubercle. At TS19 is part of the genital tubercle and from TS20 as the ontology becomes gender-specific it becomes part of the genital tubercle of male/female and from TS21 it is also part of the phallic urethra epithelium, which is part of genital tubercle of male/female and part of the phallic urethra.

dorsal genital swelling (syn: anterior genital swelling, dorsal genital tubercle) TS18-19: seen as a swelling on the surface of the embryo at the level of the hind limb buds, adjacent to the urogenital sinus and anterior/cranial to the ventrolateral genital swellings and

cloaca. Will fuse with the ventrolateral genital swellings to form part of a single genital tubercle at TS19.

ventrolateral genital swelling (syn: lateral plate mesoderm buds, or ventrolateral genital tubercle) (TS18-19): seen as paired lateral swellings on the surface of the embryo at the level of the hind limb buds, adjacent to the cloaca. Will fuse together and with the dorsal genital swelling, to form part of a single genital tubercle at TS19.

urogenital membrane (TS19-26): comprised of the urethral plate epithelium (cloacal endoderm-derived) and the surface ectoderm/skin (ectoderm-derived), where these two different epithelia are in direct contact. Part of the genital tubercle at TS19, and then part of the genital tubercle of male/female from TS20-25, then part of the penis/clitoris at TS26.

EMAPA: 17381	TS16-TS28				reproductive system
EMAPA: 17382	TS19-TS19				genital tubercle
EMAPA: 30077	TS19-TS19				dorsal genital swelling (syn: dorsal genital tubercle, anterior genital swelling)
EMAPA: 30079	TS19-TS19				ventrolateral genital swelling (syn: ventrolateral genital tubercle, lateral plate mesoderm buds)
EMAPA: 31518	TS19-TS19				urethral plate epithelium (syn: urethral plate; urethral seam)
EMAPA: 36315	TS19-TS19				surface ectoderm of genital tubercle
EMAPA: 17378	TS19-TS19				urogenital membrane (Alt ID: EMAPA:17210)
EMAPA: xxxxx	TS19-TS19				urethral plate epithelium of urogenital membrane
EMAPA: xxxxx	TS19-TS19				surface ectoderm of urogenital membrane

Genital tubercle of male/female (from TS20)

genital tubercle of male/female (syn: penis anlage/clitoris anlage) (TS20): a medial swelling seen at the level of the hind limb buds, adjacent to the cloaca and posterior/caudal to the urogenital sinus. The genital tubercle is separated into male and female, therefore you must know the sex of the embryo. At TS20, the genital tubercle of male/female is comprised of genital tubercle mesenchyme of male/female, urethral plate epithelium of male/female, skin of genital tubercle of male/female, the urogenital membrane of male/female, and developing vasculature of male/female genital tubercle. The urethral plate epithelium and skin together, where they are in direct contact, are known as the urogenital membrane. After TS20, the genital tubercle becomes further subdivided. Will become the penis/clitoris at TS26.

epithelium of phallic urethra of male/female (TS20-25): derived from cloacal endoderm and derived from the urethral plate epithelium (TS19). Located within the genital tubercle of male/female. At TS20, the urethral plate epithelium has not canalised and only the plate is seen. At TS21, as the plate begins to canalise and form a tube, it is subdivided into the urethral plate epithelium of male/female (syn: urethral plate), the bilaminar epithelium located distally, and into the phallic urethral tube epithelium (syn: proximal phallic urethral epithelium) which is the part of the urethral epithelium that has septated into a canalised tube proximally, and it is open at the proximal urethral meatus. The proximal urethral meatus closes in males, a process which begins around TS23 and is not present in

males at TS25. In females, the proximal urethral meatus remains open to TS27 (closed by TS28, p8). The epithelium of phallic urethra of male/female becomes the epithelium of penile urethra/clitoral urethra at TS26.

urethral plate epithelium of male/female (syn: urethral plate) (TS20-26 in females; TS20-24 in males); a bilaminar epithelium, which at TS20 is located along the ventral mid-line of the genital tubercle of male/female. Derived from the urethral plate epithelium (TS19). This bilayered epithelium often called the urethral plate, is marked by *Shh*, and continues to grow distally as the genital tubercle grows distally. At TS20 is part of the genital tubercle of male/female and from TS21 is part of the epithelium of phallic urethra of male/female, which is part of genital tubercle of male/female and is also part of the phallic urethra of male/female. From TS21-24 it is located at the distal end of the phallic urethra of male/female. At TS25 in males, the urethra has completely canalised (is fully patent); the urethral plate is no longer seen, the urethra opens at the urethral meatus and the proximal urethral meatus has closed. The urethral plate epithelium is only present in females from this TS25. From TS26, the urethral plate epithelium of female is part of the clitoris, located distally, and part of the epithelium of clitoral urethra. At TS27 it is no longer seen in females.

urethral tube epithelium of male/female (syn: proximal urethral epithelium of male/female): the open, proximal part of the epithelium of phallic urethra of male/female that has canalised into a tube. This structure is distinct from the urethral plate epithelium – when the urethral plate epithelium opens, forming a lumen, it is referred to as the urethral tube epithelium. During development, the tube progresses distally as canalisation progresses distally. First seen at TS21 in the proximal genital tubercle of male/female.

urogenital membrane of male/female (TS20-26): comprised of the urethral plate epithelium (cloacal endoderm-derived) and the skin (ectoderm-derived), where the two different epithelia are in direct contact. (Note: distinct to the cloacal membrane, which is comprised of the regions of surface ectoderm and cloacal epithelium in contact with each other and part of the cloaca). Part of the genital tubercle at TS19, and then part of the genital tubercle of male/female from TS20-25, then part of the penis/clitoris at TS26. At TS27 it is no longer seen in males and females, as the urethral plate is no longer present.

genital tubercle mesenchyme of male/female (TS20): the mesenchyme of the genital tubercle surrounding the epithelium of phallic urethra of male/female.

Genital tubercle TS20:

EMAPA: 17381	TS16-TS28				reproductive system
EMAPA: 17968	TS20-TS28				male reproductive system
EMAPA: 30977	TS20-TS28				male external genitalia
EMAPA: 17969	TS20-TS24				genital tubercle of male (syn: penis anlage)
EMAPA: 29170	TS20-TS20				genital tubercle skin surface epithelium of male
EMAPA: 29167	TS20-TS20				genital tubercle mesenchyme of male
EMAPA: 31507	TS20-TS24				urethral plate epithelium of male (syn: distal urethral epithelium of male; urethral plate)
EMAPA: 31510	TS20-TS24				developing vasculature of male genital tubercle

EMAPA : xxxxxx	TS20-TS25						↳ urogenital membrane of male
EMAPA : xxxxxx	TS20-TS25						↳ urethral plate epithelium of urogenital membrane of male
EMAPA : xxxxxx	TS20-TS25						↳ skin of urogenital membrane of male
EMAPA : 17381	TS16-TS28						↳ reproductive system
EMAPA : 17959	TS20-TS28						↳ female reproductive system
EMAPA : 30984	TS20-TS28						↳ female external genitalia
EMAPA : 18680	TS20-TS24						↳ genital tubercle of female (syn: clitoris anlage)
EMAPA : 29626	TS20-TS20						↳ genital tubercle skin surface epithelium of female
EMAPA : 29621	TS20-TS20						↳ genital tubercle mesenchyme of female
EMAPA : 31503	TS20-TS24						↳ developing vasculature of female genital tubercle
EMAPA : 31536	TS20-TS25						↳ urethral plate epithelium of female (syn: distal urethral
EMAPA : xxxxxx	TS20-TS25						↳ urogenital membrane of female
EMAPA : xxxxxx	TS20-TS25						↳ urethral plate epithelium of urogenital membrane of female
EMAPA : xxxxxx	TS20-TS25						↳ skin of urogenital membrane of female

Genital tubercle TS21-22:

genital tubercle of male/female (syn: penis anlage/clitoris anlage) (TS21-22): located medially, at the level of the hind limb of the embryo. The genital tubercle is separated into male and female, therefore you must know the sex of the embryo. At TS21 the genital tubercle of male/female is subdivided into distal genital tubercle of male/female (TS21-22) (syn: early glans of male/female), proximal genital tubercle of male/female (TS21-22) and preputial swelling of male/female. Also contains phallic urethra of male/female, developing vasculature of male/female genital tubercle and nerve of male/female genital tubercle (from TS22). Also contains urogenital membrane of male/female (the urethral plate epithelium and skin together, where they are in direct contact). Will become the penis/clitoris at TS25.

preputial swelling of male/female (TS21-23) (syn: preputial fold, early prepuce): two lateral swellings develop on the sides of the genital tubercle at TS21 and grow medially and ventrally. These swellings enclose the preputial glands. Comprised of skin of male/female preputial swelling, preputial gland of male/female, and mesenchyme of male/female preputial swelling. At TS24, when the two preputial swellings join/fuse together at the ventral midline of the genital tubercle of male/female, they become the prepuce of male/female.

nerve of male/female genital tubercle (TS22-24): nerve located in the genital tubercle of male/female, dorsal to the phallic urethra of male/female. Becomes dorsal nerve of penis/clitoris (TS25-28).

Genital tubercle of male TS21-22:

EMAPA : 17381	TS19-TS28						↳ reproductive system
EMAPA : 17968	TS20-TS28						↳ male reproductive system
EMAPA : 30977	G TS20-TS28						↳ male external genitalia
EMAPA : 17969	TS20-TS24						↳ genital tubercle of male (syn: penis anlage)

EMAPA:17956	TS21-TS24							phallic urethra of male (syn: external urethra of male)
EMAPA:30467	TS21-TS24							urethral epithelium of male phallic urethra (syn: urethral plate; urethral seam)
EMAPA:31507	TS20-TS24							urethral plate epithelium of male (syn: distal urethral epithelium of male; urethral plate)
EMAPA:31508	TS21- TS24							urethral tube epithelium of male (syn: proximal urethral epithelium of male)
EMAPA:31505	TS21-TS23							└ urethral duct of male (syn: proximal urethral opening of male)
EMAPA:29205	TS21-TS22							└ distal genital tubercle of male (syn: early glans of male)
EMAPA:29209	TS21-TS22							└ skin (of distal genital tubercle of male)
EMAPA:29207	TS21-TS22							└ mesenchyme of distal genital tubercle of male
EMAPA:31504	TS21-TS22							└ proximal genital tubercle of male
EMAPA:31502	TS21-TS22							└ skin (of proximal genital tubercle of male)
EMAPA:31501	TS21-TS22							└ mesenchyme of proximal genital tubercle of male
EMAPA:29220	TS21-TS23							└ preputial swelling of male (syn: preputial fold , syn: early prepuce of male)
EMAPA:29223	TS21-TS23							└ skin of male preputial swelling
EMAPA:30502	TS21-TS23							└ preputial gland of male
EMAPA:29226	TS21-TS23							└ mesenchyme of male preputial swelling
EMAPA:31510	TS20- TS24							└ developing vasculature of male genital tubercle
EMAPA:xxxxxx	TS22-TS24							└ nerve of male genital tubercle
EMAPA:xxxxxx	TS20-TS25							└ urogenital membrane of female
EMAPA:xxxxxx	TS20-TS25							└ urethral plate epithelium of urogenital membrane of female
EMAPA:xxxxxx	TS20-TS25							└ skin of urogenital membrane of female

Female TS21-22:

EMAPA:17381	TS19-TS28							└ reproductive system
EMAPA:17959	TS20-TS28							└ female reproductive system
EMAPA:30984	TS20-TS28							└ female external genitalia
EMAPA:18680	TS20-TS24							└ genital tubercle of female (syn: clitoris anlage)
EMAPA:36433	TS21-TS24							└ phallic urethra of female
EMAPA:30470	TS21-TS24							└ epithelium of phallic urethra of female
EMAPA:31536	TS21-TS24							└ urethral plate epithelium of female (syn: urethral plate of female, distal urethral epithelium of female)
EMAPA:31530	TS21-TS24							└ urethral tube epithelium of female (syn: proximal urethral epithelium of female)
EMAPA:31531	TS21-TS24							└ urethral duct of female (syn: proximal urethral opening of female)
EMAPA:30478	TS21-TS23							└ preputial swelling of female (syn: preputial fold , syn: early prepuce of female)
EMAPA:30496	TS21-TS23							└ skin of female preputial swelling
EMAPA:30499	TS21-TS23							└ preputial gland of female
EMAPA:30493	TS21-TS23							└ mesenchyme of female preputial swelling
EMAPA:30484	TS21-TS22							└ distal genital tubercle of female (syn: early glans of female)
EMAPA:30490	TS21-TS22							└ skin of distal genital tubercle of female
EMAPA:30487	TS21-TS22							└ mesenchyme of distal genital tubercle of female
EMAPA:31506	TS21-TS22							└ proximal genital tubercle of female
EMAPA:31535	TS21-TS22							└ skin of proximal genital tubercle of female
EMAPA:31534	TS21-TS22							└ mesenchyme of proximal genital tubercle of female
EMAPA:31503	TS20- TS24							└ developing vasculature of female genital tubercle
EMAPA:xxxxxx	TS22-TS24							└ nerve of female genital tubercle
EMAPA:xxxxxx	TS20-TS25							└ urogenital membrane of female
EMAPA:xxxxxx	TS20-TS25							└ urethral plate epithelium of urogenital membrane of female
EMAPA:xxxxxx	TS20-TS25							└ skin of urogenital membrane of female
EMAPA:xxxxxx	TS23-TS27							└ vasculature of phallic urethra of female

Genital tubercle TS23-24:

genital tubercle of male/female (syn: penis anlage/clitoris anlage) (TS23): located medially, at the level of the hind limb of the embryo. The genital tubercle is separated into male and female therefore you must know the sex of the embryo. At TS23 the genital tubercle of male/female is subdivided into glans of male/female genital tubercle (located distally) and preputial swelling (located proximally). Also contains phallic urethra of male/female, developing vasculature of male/female genital tubercle and nerve of male/female genital tubercle (from TS22). Also contains urogenital membrane of male/female (the urethral plate epithelium and skin together, where they are in direct contact). Will become the penis/clitoris at TS25.

genital tubercle of male/female (syn: penis anlage/clitoris anlage) (TS24): located medially, at the level of the hind limb of the embryo. The genital tubercle is separated into male and female therefore you must know the sex of the embryo. At TS24, it is subdivided into glans of male/female genital tubercle (located distally) and prepuce of male/female at TS24 (located proximally). Also contains phallic urethra of male/female, developing vasculature of male/female genital tubercle and nerve of male/female genital tubercle (from TS22). Also contains urogenital membrane of male/female (the urethral plate epithelium and skin together, where they are in direct contact). Will become the penis/clitoris at TS25.

glans of male/female genital tubercle (TS23-24): the distal part of the genital tubercle of male/female, comprised of skin and mesenchyme of glans of male/female genital tubercle. Derived from distal genital tubercle of male/female. The distal end of the phallic urethra of male/female is located within the glans, including the urethral plate epithelium of male/female and part of the urethral tube epithelium of male/female. Becomes the glans penis/glans clitoris (TS25), when genital tubercle of male/female becomes penis/clitoris.

prepuce of male/female (TS24): comprised of prepuce skin, preputial gland and prepuce mesenchyme of male/female. Part of the genital tubercle of male/female (TS24) and from TS25-28 part of penis in males and clitoris in females. Derived from preputial swelling of male/female (TS21-23).

Genital tubercle of male TS23-24:

EMAPA:17381	TS19-TS28									reproductive system
EMAPA:17968	TS20-TS28									male reproductive system
EMAPA:30977 G	TS20-TS28									male external genitalia
EMAPA:17969	TS20-TS24									genital tubercle of male (syn: penis anlage)
EMAPA:17956	TS21-TS24									phallic urethra of male (syn: external urethra of male)
EMAPA:30467	TS21-TS24									urethral epithelium of male phallic urethra (syn: urethral plate; urethral seam)
EMAPA:31507	TS20-TS24									urethral plate epithelium of male (syn: distal urethral epithelium of male; urethral plate)
EMAPA:31508	TS21-TS24									urethral tube epithelium of male (syn: proximal urethral epithelium of male)
EMAPA:31505	TS21-TS24									proximal urethral meatus of male (syn: proximal urethral opening of male, urethral duct)

EMAPA : 30707	TS24-TS24								prepuce surface epithelium skin of female
EMAPA : 30711	TS24-TS24								preputial gland of female
EMAPA : 30703	TS24-TS24							L	prepuce mesenchyme of female
EMAPA : 31503	TS20-TS24								developing vasculature of female genital tubercle
EMAPA : xxxxxx	TS22-TS24							L	nerve of female genital tubercle
EMAPA : xxxxxx	TS20-TS25							L	urogenital membrane of female
EMAPA : xxxxxx	TS20-TS25								urethral plate epithelium of urogenital membrane of female
EMAPA : xxxxxx	TS20-TS25							L	skin of urogenital membrane of female

Penis and clitoris

Penis (TS25-28): comprised of glans penis (distally), penile body (proximally) and surrounded by the prepuce. The penis contains within it, erectile tissues (corpora cavernosa glandis, urethra and MUMP corpus cavernosum), cartilage (hyaline cartilage of os penis and MUMP cartilage), bone (bone of os penis), nerves, vasculature and lamina propria (connective tissue) and is surrounded by skin. The penis is mobile. The penis also contains within it the penile urethra, located along the length of the penis and the urethral seam, located underneath the ventral midline skin of the penis. The glans penis is positioned at a right angle bend to the penile body, following the bend of the urethra. The bend in the male urethra is called the sigmoid flexure. Derived from the genital tubercle of male.

urethral seam (syn: urethral raphe, ventral seam) (TS24 -TS28): in the male, growth from mesenchyme ventral to the phallic urethra closes the proximal urethral meatus and septates the epithelium of phallic urethra. This results in the centrally positioned phallic urethra and the ventrally positioned urethral seam. The urethral seam is a solid epithelial cord present underneath the skin along the ventral midline of the penis. Septation moves in a proximal to distal direction along the penis during development and the urethral seam is retained in the adult penis. Part of the genital tubercle of male (TS24), part of the penis (TS25-TS28) and also part of phallic urethra of male (TS24) and penile urethra.

glans penis (TS25-28, syn: penile glans): the distal part of the penis. The glans penis lies internally within the preputial space and externally is completely surrounded by the prepuce. The glans can be exposed when the prepuce is retracted. The distal part of the penile urethra is located within the glans penis. From TS25-27, is comprised of skin and mesenchyme of glans penis. At TS28, is comprised of corpus cavernosum glandis (two, linear corpora cavernosa, dorsally and ventrally located within the glans penis), corpus cavernosum urethra (linear erectile tissue ventral to the urethra), male urogenital mating protuberance (MUMP), os penis and lamina propria (stroma or connective tissue) and covered with skin. The glans penis is comprised of regions; the MUMP ridge (which encircles the glans and is comprised of a ridge (distal) and a groove (proximal) the MUMP ridge groove), and proximal to the ridge is the glandular ridge. The urethral meatus (the opening of the male penile urethra) is located at a ventral midline cleft in the MUMP ridge close to the distal tip of the glans penis (~1mm from the tip).

Glans penis skin: the glans penis is covered with skin that contains keratinized epithelial spines.

Corpus cavernosum of glans penis (syn: corpora cavernosa plural): erectile tissues of the glans penis, including the corpus cavernosum urethra, two corpus cavernosum glandis, male urogenital mating protuberance corpus cavernosum.

Corpus cavernosum urethra: the band of erectile tissue that runs ventral to the penile urethra. Located within the penis, partly within the glans penis and partly within the body of the penis. Erectile tissue is derived from condensations that form from the mesenchyme of the penis.

corpus cavernosum glandis (syn: corpora cavernosa glandis): two, linear corpora cavernosa erectile tissue located dorsally and ventrally within the glans penis.

corpus cavernosum of penile body (syn: crus, crura): located within the penile body, paired erectile tissues that extend laterally from the base of the penis towards the pubic bone, and are anchored to the pubic bone on each ischial tuberosity.

male urogenital mating protuberance (syn: MUMP), a tapered extension of the os penis, located at the distal end of the glans penis. The MUMP is ~1.7mm long, comprised of a fibrocartilage core called MUMP cartilage, surrounded by two MUMP corpus cavernosum (lie on lateral sides of the MUMP fibrocartilage core), and covered with skin. The MUMP boundary is defined by the MUMP ridge, a groove that encircles the distal glans penis.

MUMP ridge: a groove that encircles the distal glans penis and defines the boundary of the MUMP.

Glandular ridge: ridge on the outside of the glans penis, encircles the distal glans penis.

os penis: bone and cartilage located in the centre of the glans penis, dorsal to the penile urethra. The os penis is ~3.8mm long (although its size is variable) and overlaps the proximal end of the MUMP, located from the MUMP ridge groove to the junction of the glans penis and body of the penis. Comprised of proximal hyaline cartilage of os penis (proximally), which undergoes calcification to form the bone of os penis, distally, at ~6 months age.

Prepuce of male (TS25-27, TS28): the external part of the penis that completely surrounds the glans penis. The glans can be exposed when the prepuce is retracted. Contains the preputial glands and mesenchyme of prepuce and surrounded by skin. The preputial gland ducts drain into the preputial space. From TS28, prepuce is comprised of skin containing hair follicles, preputial gland (paired), which drain into the preputial space and prepuce lamina propria (stroma or connective tissue).

Penile body (syn: body of penis): proximal part of penis. Connected to the glans penis at a right angle bend. Contains within it, the proximal part of the penile urethra. Comprised of paired corpora cavernosa, corpus cavernosum urethra and lamina propria (stroma, connective tissue).

penile urethra (syn: external urethra of male) (TS25-TS28): comprised of epithelium of penile urethra. Epithelium of penile urethra (TS25-TS28) derived from epithelium of phallic urethra of male/female (TS21-TS24). The urethral plate epithelium of male (syn: distal

clitoris (TS25-TS28): comprised of glans clitoris (distally), body of clitoris (proximally) and surrounded by the prepuce of female. The clitoris contains within it, bone of the os clitoridis, nerves, vasculature and lamina propria (connective tissue) and is surrounded by the skin of female prepuce. The clitoris also contains within it the clitoral urethra, which is linear, positioned ventrally within the clitoris and remains in contact with the ventral surface of the clitoris. An opening forms in the clitoral urethra, called the urethral meatus, located within the glans clitoris, which is seen at birth. The female urethra is also open at the proximal urethral meatus at the base of the clitoris until a week after birth. The proximal urethral meatus is closed by P8. The clitoral urethra forms a large, U-shaped urethral cleft that extends from the body of clitoris to the glans clitoris, and is surrounded by a solid, U-shaped lamina propria (of glans clitoris and body of clitoris), which are both surrounded by the lamina propria of prepuce. There is no preputial space. The clitoris is much smaller than the penis and the os clitoridis is minuscule compared to the size of the os penis. The clitoris does not contain cartilage or erectile tissues and does not contain epithelial spines. The clitoris is not mobile, it is ventrally tethered to the prepuce and does not lie within a preputial space. Derived from the genital tubercle of female.

glans clitoris (TS25-28, syn: clitoral glans): the distal part of the clitoris. The glans clitoris is surrounded by the prepuce but it does not lie within a preputial space. The distal part of the clitoral urethra is located within the glans clitoris. An opening forms in the clitoral urethra in the glans clitoris, seen at birth. The urethra forms a large, U-shaped urethral cleft that extends to the tips of the glans clitoris, surrounded by a solid, U-shaped lamina propria and then surrounded by the lamina propria of prepuce. From TS25-27, is comprised of epithelium and mesenchyme of glans clitoris. At TS28, is comprised of epithelium and lamina propria of glans clitoris. The epithelium of glans clitoris located dorsally in the clitoris and in direct contact with urethral epithelium. The distal end of the glans clitoris is located just proximal to the urethral opening. The lamina propria contains many diffuse blood vessels.

os clitoridis: tiny bone, variable in size (between 581-1840 um long, dependant on strain), located within the clitoris.

Body of clitoris (syn: clitoral body): the proximal part of the clitoris, contains epithelium, lamina propria, os clitoridis and part of the clitoral urethra. The lamina propria contains many diffuse blood vessels and a larger midline dorsal vein in the body of clitoris. The clitoral urethra forms a large, U-shaped urethral cleft that extends from the body of clitoris to the glans clitoris, surrounded by a solid, U-shaped lamina propria, which are both surrounded by the prepuce.

prepuce of female (TS25-TS28): the prepuce of female surrounds the glans clitoris and body of clitoris, but does not contain a preputial space. TS25-TS27 prepuce of female is comprised of skin, preputial glands and mesenchyme of prepuce. From TS28, prepuce of female is comprised of skin, preputial glands and lamina propria of prepuce.

clitoral urethra (syn: external urethra of female) (TS25-TS28): comprised of epithelium of clitoral urethra. Epithelium of clitoral urethra (TS25-28) derived from epithelium of phallic urethra of male/female (TS21-24). At TS25, the epithelium is subdivided into along its distal-proximal length into urethral plate epithelium (distal) and urethral tube epithelium (proximal). The urethral plate epithelium of female (syn: distal urethral epithelium of female; urethral plate of female) is no longer present from TS26. The clitoral urethra is open proximally at the proximal urethral meatus (present to P7) (syn: proximal urethral opening of female or urethral duct) located at the base of the clitoris. The proximal urethral meatus closes after birth (closed by P8). In adults and from birth, the urethra of female is open externally at the urethral meatus of clitoral urethra (syn: distal urethral opening of female) which is anatomically located within the clitoris. (This is different to humans, where the urethral opening is located between the clitoris and vagina.) The clitoral urethra is anatomically located ventrally within the clitoris and is surrounded by the tissue of the clitoris, therefore only the epithelial components are necessary parts of clitoral urethra.

EMAPA: 30819	TS25-TS28								clitoris
EMAPA: 30829	TS25-TS28								glans clitoris
EMAPA: 30831	TS25-TS28								epithelium surface epithelium of glans clitoris Alt ID: EMAPA:30720
EMAPA: 30715	TS25-TS27								mesenchyme of glans clitoris
EMAPA: 30833	TS28-TS28								mesenchymal layer of glans clitoris lamina propria of glans clitoris
EMAPA: 30821	TS25-TS28								body of clitoris crus of clitoris (syn: clitoral body) Alt ID: EMAPA:19169
EMAPA: 30825	TS25-TS28								epithelium layer of body of clitoris crus of clitoris Alt ID: EMAPA:30730
EMAPA: 30827	TS25-TS28								lamina propria mesenchymal layer of body of clitoris crus of clitoris Alt ID: EMAPA:30725
EMAPA: 30823	TS28-TS28								os clitoridis clitoris
EMAPA: 30699	TS25-TS28								prepuce of female
EMAPA: 30707	TS25-TS28								skin of female prepuce
EMAPA: 36409	TS28-TS28								hair follicle of female prepuce
EMAPA: 30711	TS25-TS28								preputial gland of female (syn: preputial duct)
EMAPA: 30703	TS25-TS27								prepuce mesenchyme of female
EMAPA: 36410	TS28-TS28								lamina propria of female prepuce (syn: stroma, connective tissue)
EMAPA: 30917	TS25-TS28								phallic clitoral urethra of female (syn: external urethra of female)
EMAPA: 30930	TS25-TS28								urothelium of phallic epithelium of clitoral urethra of female
EMAPA: 30924	TS25-TS25								urethral plate epithelium of clitoral urethra of female (syn: urethral plate of female, distal urethral epithelium of female)
EMAPA: xxxxxx	TS25-TS25								urethral tube epithelium of clitoral urethra (syn: proximal urethral epithelium of female)
EMAPA: xxxxxx	TS25-TS28								proximal urethral meatus of clitoral urethra (present to P7) (syn: proximal urethral opening of female, urethral duct)
EMAPA: xxxxxx	TS27-TS28								urethral meatus of clitoral urethra (syn: distal urethral opening of female)
EMAPA: 30835	TS25-TS28								vasculature of clitoris
EMAPA: 35044	TS25-TS28								nerve of clitoris

Labioscrotal swellings, folds and scrotum/labia.

Previously termed labioscrotal swellings and folds of female/male, the terms have been renamed labial swelling and fold and scrotal swelling and fold.

scrotal swelling (TS22-23): two lateral swellings develop ventrally, at the base of the genital tubercle of male. Comprised of skin, mesenchyme and developing vasculature of scrotal swelling. At TS24, becomes the scrotal fold and then scrotum at TS28. Part of the male external genitalia and male reproductive system. Scrotal swellings are larger than labial swellings in female.

Scrotal fold (TS24-27): two lateral scrotal folds are located ventrally at the base of the genital tubercle of male/penis, comprised of scrotal fold mesenchyme, skin and developing vasculature. Develop from scrotal swellings. The scrotal folds join at the ventral midline (or perineal seam) at around TS25, at the septum of scrotal fold. Become the scrotum at TS28. Part of the male external genitalia and male reproductive system. Scrotal fold is larger than labial fold in female.

Scrotum (TS28): located at the base of the penis and comprised of skin (epidermal layer of scrotum (comprised of basal layer and stratified layer), dermal layer of scrotum (comprised of hair follicle and sweat gland), septum of scrotum (or scrotal seam)), vasculature and nerve of scrotum. Derived from scrotal fold (TS24-27).

EMAPA: 17381	TS19-TS28					reproductive system
EMAPA: 17968	TS20-TS28					male reproductive system
EMAPA: 30977	TS20 -TS28					male external genitalia
EMAPA: 30509	TS22-TS23					labioscrotal swelling of male
EMAPA: 30515	TS22-TS23					scrotal swelling skin surface epithelium of labioscrotal swelling of male
EMAPA: 30512	TS22-TS23					mesenchyme of scrotal swelling mesenchyme of labioscrotal swelling of male
EMAPA: 36413	TS22-TS23					developing vasculature of labioscrotal swelling
EMAPA: 29316	TS24-TS27					scrotal fold
EMAPA: 30627	TS24-TS27					skin of scrotal fold scrotal fold surface epithelium of male
EMAPA: 30624	TS24-TS27					mesenchyme of scrotal fold scrotal fold mesenchyme of male
EMAPA: 36414	TS25-TS27					septum of scrotal fold (syn: scrotal seam)
EMAPA: 36415	TS24-TS27					developing vasculature of scrotal fold
EMAPA: 19296 >	TS28-TS28					scrotum
EMAPA: 36411 >	TS28-TS28					scrotum skin
EMAPA: 29733	TS28-TS28					epidermal layer of scrotum
EMAPA: 29735	TS28-TS28					basal layer of scrotum
EMAPA: 29737	TS28-TS28					stratified layer of scrotum
EMAPA: 29739	TS28-TS28					dermal layer of scrotum
EMAPA: 29741	TS28-TS28					hair follicle of scrotum
EMAPA: 29743	TS28-TS28					sweat gland of scrotum
EMAPA: 29745	TS28-TS28					septum of scrotum (syn: scrotal seam)
EMAPA: 36412	TS28-TS28					lamina propria of scrotum (syn: stroma, connective tissue)
EMAPA: 30791	TS28-TS28					vasculature of scrotum
EMAPA: 35050	TS28-TS28					nerve of scrotum

Labial swelling (TS22-23): two lateral swellings develop ventrally, at the base of the genital tubercle of female. Comprised of skin, mesenchyme and developing vasculature of labial swelling. At TS24, becomes the labial fold and then labia at TS28. Part of the female external genitalia and female reproductive system. Scrotal swellings are larger than labial swellings in female.

labial fold (TS24-TS27): two lateral labial folds are located ventrally at the base of the genital tubercle of female/clitoris, comprised of labial fold mesenchyme, skin and developing vasculature. Develop from labial swellings. The labial folds fuse at the ventral midline (or perineal seam) at around TS25. Become part of the perineum at TS28. Part of the female external genitalia and female reproductive system. Scrotal fold is larger than labial fold.

EMAPA:17381	TS19-TS28					reproductive system
EMAPA:17959	TS20-TS28					female reproductive system
EMAPA:30984	TS20 -TS28					female external genitalia
EMAPA:30423	TS22-TS23					labioscrotal swelling of female labial swelling
EMAPA:30429	TS22-TS23					surface epithelium of labioscrotal swelling of female skin of labial swelling
EMAPA:30426	TS22-TS23					mesenchyme of labial swelling of labioscrotal swelling of female
EMAPA:36417	TS22-TS23					L developing vasculature of labial swelling
EMAPA:18329	TS24-TS27					labial swelling (syn: labia) fold
EMAPA:30438	TS24-TS27					surface epithelium of labial swelling labial fold skin
EMAPA:30433	TS24-TS27					mesenchyme a layer of labial swelling fold
EMAPA:36416	TS24-TS27					L developing vasculature of labial fold
EMAPA:30837	TS28 TS28	 	 	 	 	labia
EMAPA:30839	TS28 TS28	 	 	 	 	epithelial layer skin of labia
EMAPA:30843	TS28 TS28	 	 	 	 	gland of labia
EMAPA:30841	TS28 TS28	 	 	 	 	mesenchymal layer lamina propria of labia
EMAPA:30845	TS28 TS28	 	 	 	 	vasculature of labia
EMAPA:35043	TS28 TS28	 	 	 	 	L nerve of labia

The adult mouse does not have a labia and these terms have been removed from the ontology.

TS24+ gender-specific reproductive system structures

See Figure 3 (late stages) and Figure 4 (ducts)

Male

seminal vesicle (TS24-28) (syn: vesicular gland). By E16.5 circulating androgens have initiated seminal vesicle formation in the male, and paired seminal vesicle buds develop from the nephric ducts close to where they have fused with the epithelium of the pelvic urethra of male, at the verumontanum (which develops from the urogenital sinus ridge). Comprised of epithelium, lamina propria, muscle and surrounded by serosa of seminal vesicle. Also contains vasculature (TS24-28) and nerves are seen from birth (TS27). Connected to the dorsal anterior pelvic urethra via the ejaculatory duct. Seminal vesicle epithelium is marked by *Wnt9b* at E17 and seminal vesicle mesenchyme and smooth muscle are marked by *Crabp1* at E17 (Abler et al, 2011). Develops from the nephric ducts.

EMAPA:19180	TS24-TS28					seminal vesicle (syn: vesicular gland)
EMAPA:29771	TS24-TS28					epithelium lia layer of seminal vesicle
EMAPA:36418	TS24-TS28					lamina propria of seminal vesicle (syn: mesenchyme of seminal vesicle)
EMAPA:29773	TS24-TS28					muscle layer of seminal vesicle
EMAPA:29775	TS24-TS28					serosa adventitia of seminal vesicle
EMAPA:30797	TS24-TS28					vasculature of seminal vesicle
EMAPA:35048	TS27-TS28					nerve of seminal vesicle

ejaculatory duct (TS24-28): comprised of epithelium, lamina propria and muscle of ejaculatory duct and surrounded by adventitia. Also contains vasculature (TS24-28) and nerves are seen from birth (TS27). Epithelium is marked by *Krt14*, lamina propria by *Foxf1a* and muscle of ejaculatory duct is marked by *Crabp1* at E17 (Abler et al, 2011). Connects the seminal vesicle and ductus deferens to the pelvic urethra. Derived from the nephric duct.

EMAPA:19088	TS24-TS28						ejaculatory duct
EMAPA:29786	TS24-TS28						epithelium of ejaculatory duct
EMAPA:32270	TS24-TS28						lamina propria mesenchymal layer of ejaculatory duct (syn: mesenchyme of ejaculatory duct)
EMAPA:32289	TS24-TS28						muscle layer of ejaculatory duct
EMAPA:36419	TS24-TS28						adventitia of ejaculatory duct
EMAPA:30799	TS24-TS28						vasculature of ejaculatory duct
EMAPA:35054	TS27-TS28						nerve of ejaculatory duct

ductus deferens (TS24-28, syn: vas deferens): derives from nephric duct of male (TS23). Connected to the dorsal anterior pelvic urethra via the ejaculatory duct. Comprised of epithelium, lamina propria and muscle and surrounded by serosa of ductus deferens. Also contains vasculature (TS24-28) and nerves are seen from birth (TS27).

EMAPA:18681	TS24-TS28						ductus deferens (syn: vas deferens)
EMAPA:29274	TS24-TS28						epithelium of ductus deferens
EMAPA:36420	TS24-TS28						lamina propria of ductus deferens (syn: mesenchyme of ductus deferens)
EMAPA:29270	TS24-TS28						muscle layer of ductus deferens
EMAPA:30055	TS28-TS28						circular muscle layer of ductus deferens
EMAPA:30057	TS28-TS28						longitudinal muscle layer of ductus deferens
EMAPA:29767	TS24-TS28						adventitia serosa of ductus deferens (Alt ID:EMAPA:30751)
EMAPA:30793	TS24-TS28						vasculature of ductus deferens
EMAPA:35049	TS27-TS28						nerve of ductus deferens

The following terms have been merged, with the appropriate terms above:

EMAPA:30751	TS26-TS27	 	 	 	 	 	outer layer of ductus deferens
EMAPA:31188	TS23-TS27	 	 	 	 	 	developing vasculature of ductus deferens

Female

vagina (TS24-TS28): comprised of epithelium, lamina propria, muscle, adventitia, vasculature and nerve of vagina. The developing vagina is subdivided into upper vagina and sinovaginal bulb (or lower vagina), however only the upper vagina will become the vagina in the adult (Kurita 2010). The sinovaginal bulb is a transient structure only seen during development. The sinovaginal bulb is derived from the urogenital sinus epithelium (and is therefore often called the sinus vagina). The adult vagina (TS28) is derived from the upper vagina (TS24-TS27), and is derived from the paramesonephric duct of female.

sinovaginal bulb (TS24-27) (syn: sinus vagina, vaginal bulb, lower part of vagina) comprised of epithelium, lamina propria, muscle, adventitia and developing vasculature. Epithelium of sinovaginal bulb is derived from urogenital sinus of female, derived from urogenital sinus epithelium.

epithelium of sinovaginal bulb: (syn: vaginal bulb epithelium, epithelium of lower part of vagina, vaginal plate) (TS24-27): the epithelium of the sinovaginal bulb. *Krt14* at E17 is specific to the epithelial layer of sinovaginal bulb (*Krt14* also present in urothelium of bladder, but absent from epithelial layer of upper vagina) (Abler et al, 2011).

Lamina propria of sinovaginal bulb (TS24-27) (syn: mesenchyme of sinovaginal bulb): the lamina propria located between the epithelial layer and the muscle. Marked by *Foxf1a*, *Crabp1*, *Amhr2* at E17 (Abler et al, 2011).

Muscle of sinovaginal bulb (TS24-27) (syn: Muscular layer of lower part of vagina): Marked by *Crabp1* E17 (Abler et al, 2011) and alpha smooth muscle actin and gamma smooth muscle actin.

Adventitia of sinovaginal bulb (syn: adventitia of lower part of vagina) (TS24-28): the outer layer of sinovaginal bulb.

Upper vagina (TS24-27) (syn: Mullerian vagina, upper part of vagina) comprised of epithelium, lamina propria, muscle and adventitia. Also contains vasculature (TS24-27) and nerves are seen from birth (TS27). Derived from paramesonephric duct of female.

epithelium of upper vagina (TS24-27) (syn: epithelial layer of upper part of vagina): the epithelial layer of upper vagina is selectively marked by *Wnt7a* at E17 (absent from sinovaginal bulb epithelium) (Abler et al, 2011).

Lamina propria of upper vagina (TS24-27) (syn: mesenchymal layer of upper part of vagina): the lamina propria, connective tissue layer located between the epithelial layer and the muscular layer of the upper vagina. Marked by *Amhr2* and *Crabp1* at E17. (Abler et al, 2011)

Muscle of upper vagina (TS24-27) (syn: muscular layer of upper part of vagina): the smooth muscle layer of the upper vagina. Marked by *Crabp1* at E17 (Abler et al, 2011) and alpha smooth muscle actin and gamma smooth muscle actin.

adventitia of upper vagina (TS24-27) (syn: adventitia of upper part of vagina): the outer layer of the lower vagina.

epithelium of vagina (TS28): the epithelial layer of the vagina. Derived from epithelium of upper vagina (TS27).

Lamina propria of vagina (TS28): the lamina propria, connective tissue layer located between the epithelial layer and the muscular layer of the vagina. Derived from lamina propria of upper vagina (TS27).

Muscle of vagina (TS28): the smooth muscle layer of the vagina. Marked by alpha smooth muscle actin. Derived from adventitia of upper vagina (TS27).

