

Development of Urogenital System

- Intermediate mesoderm forms a urogenital ridge
- Uro-genital ridge consists of laterally-positioned nephrogenic cord (that becomes kidneys & ureter) and a medially positioned gonadal ridge (for ovary/testis & female/male genital tract formation).
- Urinary & genital systems have a common embryonic origin (urogenital ridge) and they share common ducts.

Kidneys

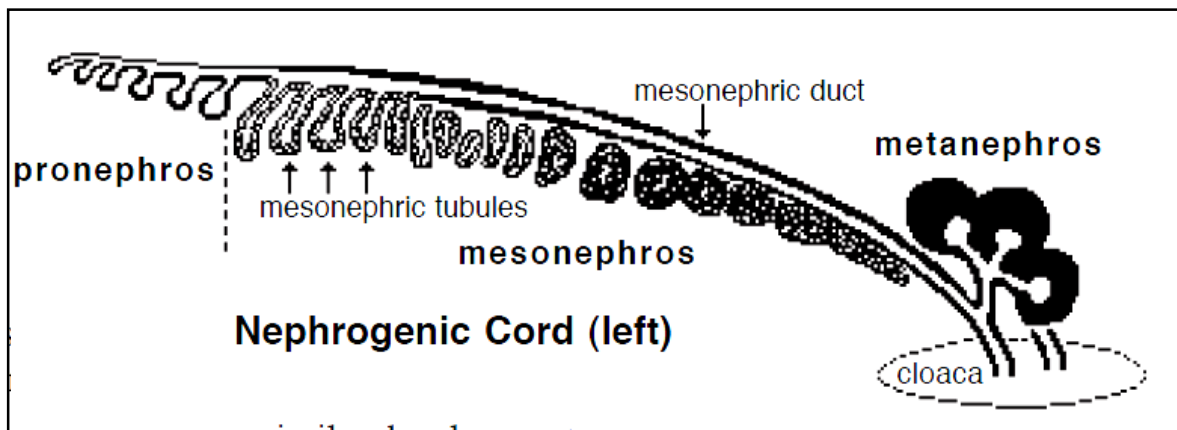


Fig. 1 Development of pro-, meso- and meta-nephros

- Three kidneys develop chronologically (cranio-caudal) from nephrogenic cord. They are : pronephros, mesonephros and metanephros
- Development of pronephros and mesonephro: have a similar development

Pronephros

- Consists of (7-8) primitive tubules and a pronephric duct
- That grows caudally and terminates in the cloaca.
- The tubules soon degenerate but the pronephric duct persists the mesonephric duct.

Mesonephros

- Consists of (70-80) tubules induced to form by the mesonephric duct (former pronephric duct)
- one end of each tubule surrounds a glomerulus (vascular proliferation produced by a branch of the dorsal aorta)
- The other end of the tubule communicates with the mesonephric duct
- Eventually, the mesonephros degenerates, but the mesonephric duct becomes epididymis & ductus deferens

Metanephros

- Becomes adult kidney & ureter of mammals, birds, and reptiles
- Originates in the pelvic region and moves cranially into the abdomen during embryonic differential growth
- Lobulated initially but becomes smooth in most species.
- The metanephros originates from two sources:
 - ❖ a ureteric bud, which grows out of the mesonephric duct near

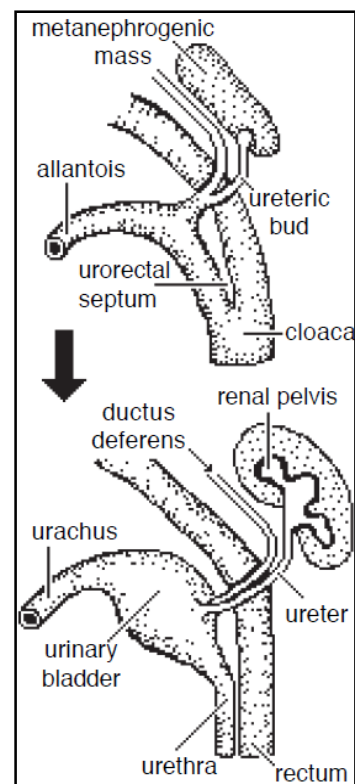


Fig. 2 Development metanephros, ureter and urinary Bladder

- the cloaca; the bud develops into the ureter, renal pelvis, and numerous collecting ducts;
- ❖ metanephrogenic mass, which is the caudal region of the nephrogenic cord; the mass forms nephrons.

Notes

- ⇒ The pronephros is not functional, except in sheep.
- ⇒ The mesonephros is functional in only some mammals
- ⇒ mesonephros becomes the functional kidney of adult fish & amphibians.
- ⇒ The metanephros becomes the functional kidney of adult reptiles, birds, & mammals.
- ⇒ Although kidneys may be functional in-utero, they are not essential because the placenta is able to remove toxic agents from fetal blood.

Urinary Bladder and Urethra

- A urorectal septum divides the cloaca into:
 - Dorsally: a rectum, anal canal & anal membrane, and
 - Ventrally: a urogenital sinus and urogenital membrane
- The membranes subsequently degenerate, resulting in an anus and a urogenital orifice, respectively.
- Cranially, the urogenital sinus connects with the urachus the intra-embryonic stalk of the allantois

Urinary bladder

- develops from the cranial end of the urogenital sinus and the adjacent region of urachus growth expansion results in separate openings of the mesonephric duct and ureter into the dorsal wall of the urogenital sinus
- differential growth of the dorsal wall results in mesonephric duct and ureter openings being switched cranio-caudally, creating a trigone region (that anchors ureters to the bladder & urethra)

Urethra

- Develops from the urogenital sinus caudal to the urinary bladder
- Urethra development is gender specific:

Females:

Mid region of the urogenital sinus becomes urethra. The caudal region of the urogenital sinus becomes vestibule and the vagina grows out of the vestibule wall.

Males:

Pelvic urethra develops from the mid region of the urogenital sinus and the penile urethra develops from elongation of the caudal end of the urogenital sinus.

Note: In the fetus, urine is discharged into the allantoic cavity through the urachus and into the amniotic cavity through the urogenital orifice.

Genital System

Indifferent stage:

- Gonad originates from the gonadal ridge (a thickening of intermediate mesoderm plus coelomic mesothelium that develops medial to the mesonephric kidney).
- Gonad is composed of germ cells and supporting cells:
- Supporting cells form cellular cords (gonadal cords) that radiate into the gonadal ridge, the cells arise from invading mesothelium and disintegrating mesonephric tubules
- Germ cells arise from yolk sac endoderm, they migrate along the gut wall and mesentery to reach the gonadal ridge. Their arrival induces further gonadal development.
- Germ cells proliferate and must migrate inside gonadal cords so they are surrounded by supporting cells.

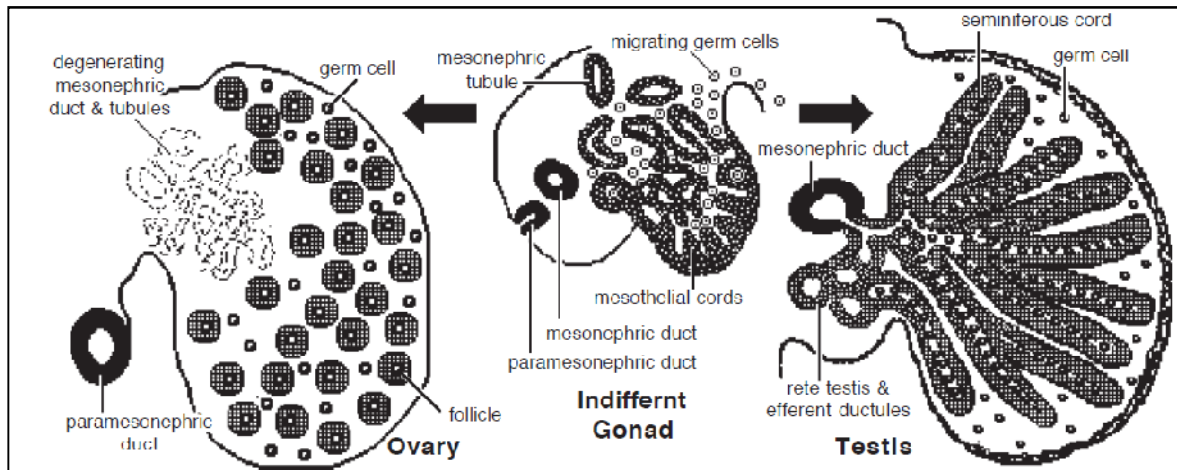


Fig. 3 Development of ovary and testis

Testis

- Gonadal cords hypertrophy and are called seminiferous cords
- Germ cells within seminiferous cords differentiate into spermatogonia and become dormant.
- At puberty, seminiferous cords become canalized, forming seminiferous tubules, and spermatogonia initiate spermatogenesis (deep cords that lack germ cells become tubules of the rete testis, located centrally in the testis).
- Supporting cells differentiate into sustentacular (Sertoli) cells and interstitial cells
- Sustentacular cells, located in walls of seminiferous tubules, secrete inhibitory factors that suppress both spermatogenesis and female duct development (paramesonephric duct)
- Interstitial cells located outside the seminiferous tubules, become two populations: one produces androgen hormones immediately, the other population delays androgen production until sexual maturity (androgens stimulate male genitalia development)
- Mesothelium covering the testis becomes visceral peritoneum; mesenchyme deep to the mesothelium becomes the tunica albuginea of the testis.

Ovary

Gonadal cords undergo reorganization and individual germ cells become surrounded by a sphere of flat supporting cells. Thus primordial follicles are formed. Germ cells (oogonia) differentiate into primary oocytes that commence meiosis, but remain stuck in prophase of Meiosis I (meiosis is not continued until ovulation occurs). Follicle and germ cell proliferation is completed *in utero* (the lifetime allotment of primary oocytes is already present in the neonatal ovary).

Genital Ducts | Accessory Glands

Indifferent stage

- Both sexes have male (mesonephric/Wolffian duct) and female (paramesonephric/Mullerian) genital ducts and a urogenital sinus
- Testicular hormones determine which duct system develops: male duct development requires testosterone, produced by interstitial cells;
- Female duct development is suppressed by an inhibitory hormone released by sustentacular cells.

Female

- In the absence of testosterone, mesonephric ducts fail to develop.
- The cranial region of each paramesonephric duct remains open and forms the future uterine tube
- Caudal to the level of the inguinal fold (gubernaculum), each paramesonephric duct becomes a uterine horn.
- Further caudally, bilateral paramesonephric ducts shift medially and fuse into a single tube that ends blindly in contact with the urogenital sinus.
- The fused ducts become: uterine body, uterine cervix, and the cranial third of the vagina.

- The vagina has a dual origin:
- The cranial one-third comes from fused paramesonephric ducts. the caudal two-thirds comes from an outgrowth of the future vestibule, as follows:
 - At the site where the fused paramesonephric ducts contact the urogenital sinus, a solid tubercle, the vaginal plate, grows outward from the future vestibule
 - Degeneration of the center of the solid tubercle creates the vaginal lumen.
 - A hymen may persist where the vagina joins urogenital sinus.

Males

- ⊙ Paramesonephric ducts regress due to an inhibitory hormone produced by sustentacular cells of the testis (remnants are uterus masculinus).
- ⊙ Several mesonephric tubules become efferent ductules
- ⊙ The cranial region of the mesonephric duct undergoes extensive elongation and coiling to become the epididymis; the remainder of the duct enlarges and becomes ductus deferens
- ⊙ The mesonephric duct (ductus deferens) empties into the region of urogenital sinus that becomes pelvic urethra.

Genital Ligaments:

- ⊙ When the mesonephros degenerates, it leaves behind a genital fold that persists to suspend the gonad and genital duct system
- ⊙ The caudal extension of the genital fold that runs along the body wall and into the inguinal region is called the inguinal fold and it gives rise to the gubernaculum of the fetus
- ⊙ The genital and inguinal folds becomes male & female genital ligaments:
- ⊙ In females: the genital fold becomes the broad ligament (suspensory ligament of the ovary, mesovarium, mesosalpinx, and mesometrium); the inguinal fold becomes the proper ligament of the ovary and round ligament of the uterus
- ⊙ In males: the genital fold becomes mesorchium and mesoductus deferens; the inguinal fold becomes the gubernaculum and the adult proper ligament of the testis and ligament of the tail of the epididymis.

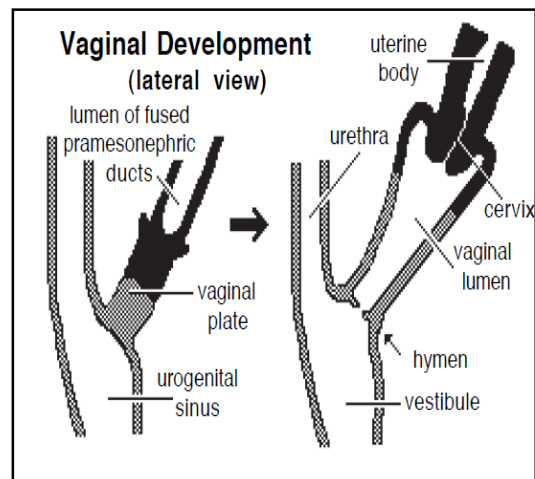


Fig. 4 Development of vagina

Mammary Glands

- ⊙ In both genders, a mammary ridge (line) is formed by the thickened ectoderm. Then mammary buds develop along the ridge. Buds determine the number and locations of mammary glands, since each bud develops into a mammary gland (2: sheep, goat, mare; 4: cow; 8: queen; 10: bitch; 14: sow) to the inguinal region.
- ⊙ In each mammary bud ectoderm induces proliferation of underlying mesoderm and mesoderm induces epithelial cell proliferation (teat formation).
- ⊙ Epithelial cell solid cords invade underlying mesoderm and eventually canalize to form epithelial lined lactiferous ducts. The number of cell cord invasions and subsequent lactiferous duct systems per teat is species dependent (approximately: 1, sheep, goat, cow; 2 mare, sow; 6, queen; 12, bitch).

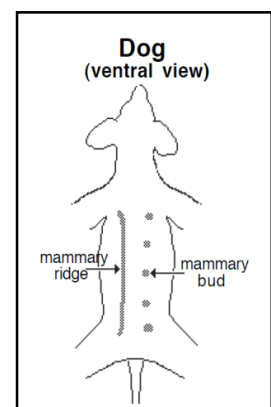


Fig. 5 Development of Mammary gland