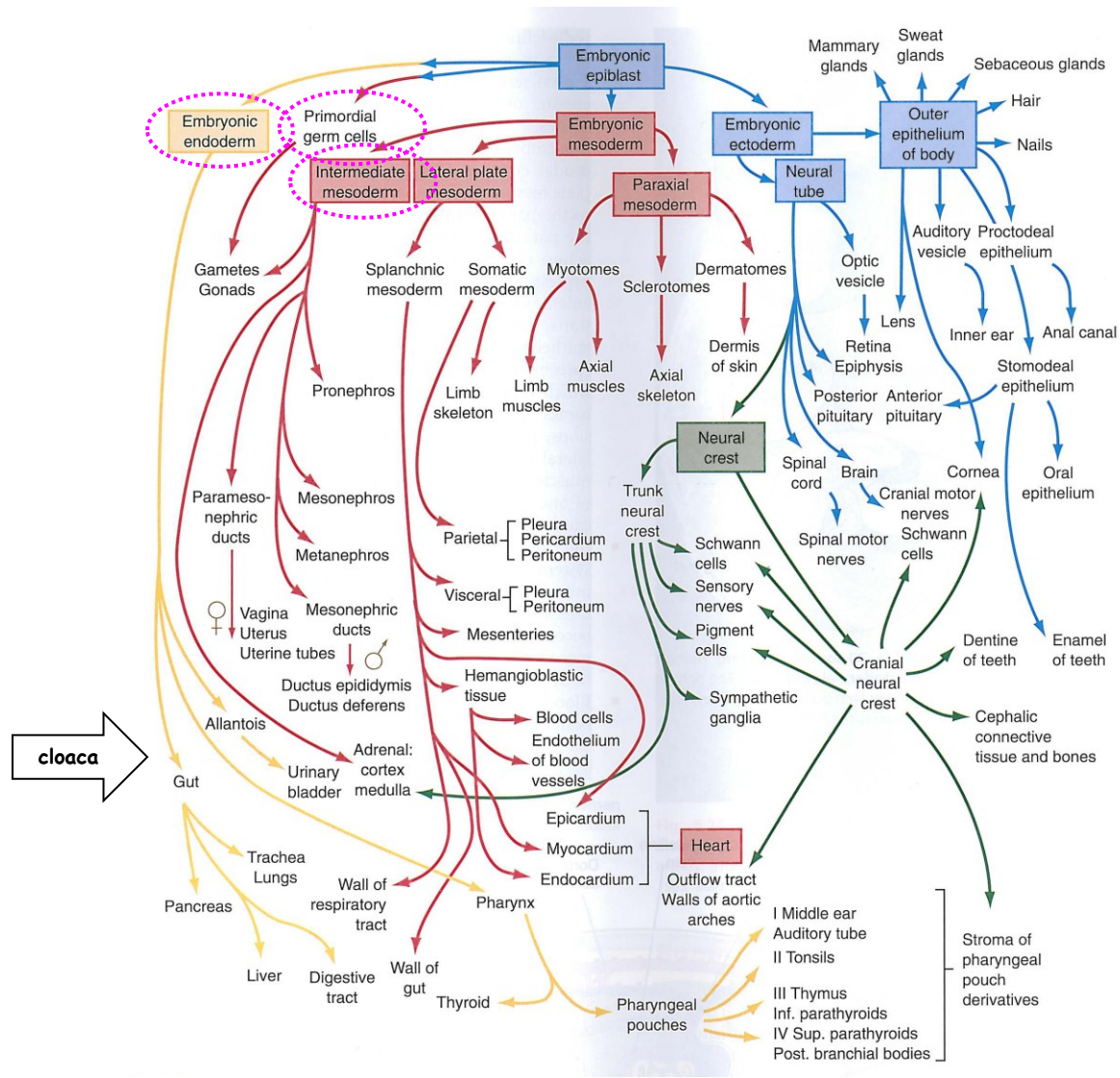


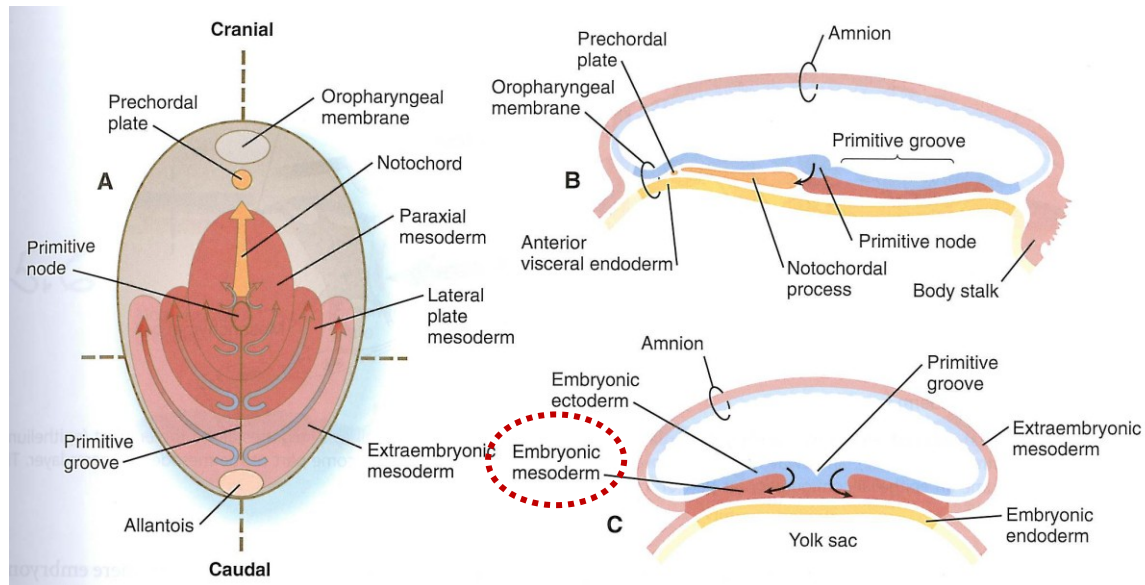
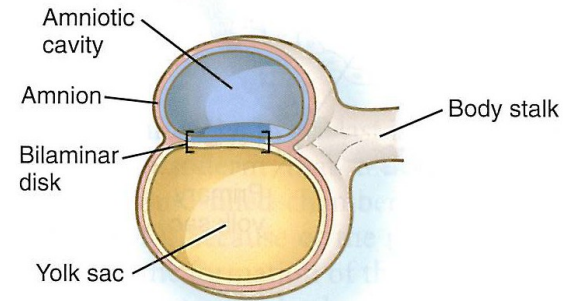
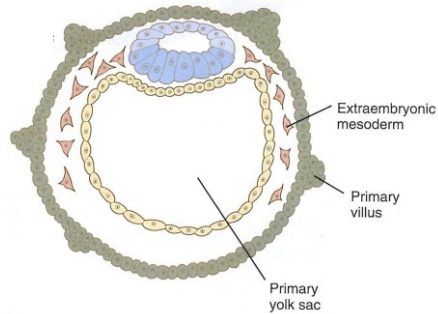
Močopohlavní systém - Vývoj

Aleš Hampl

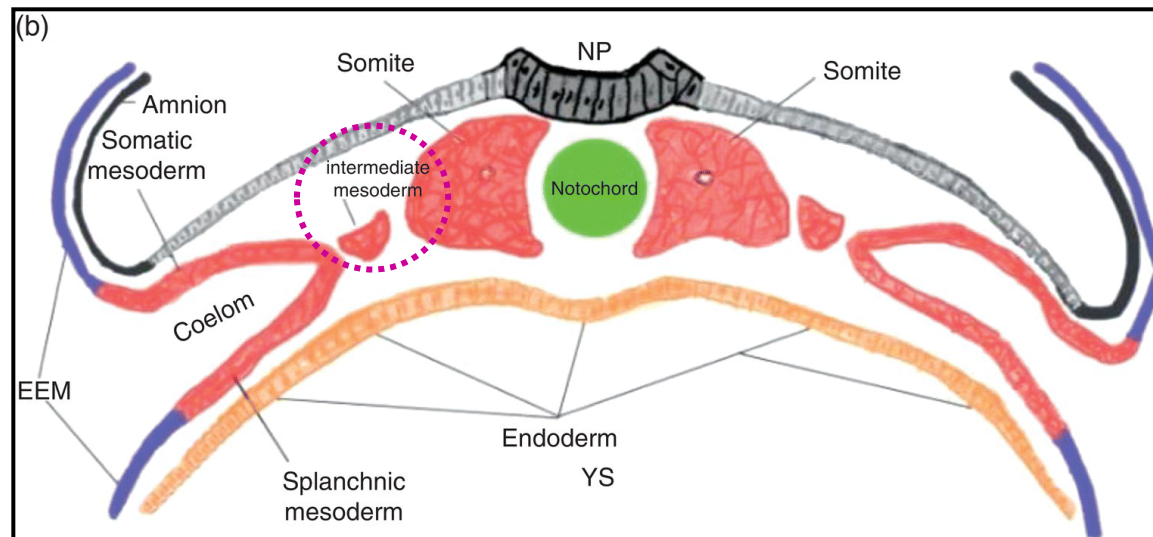
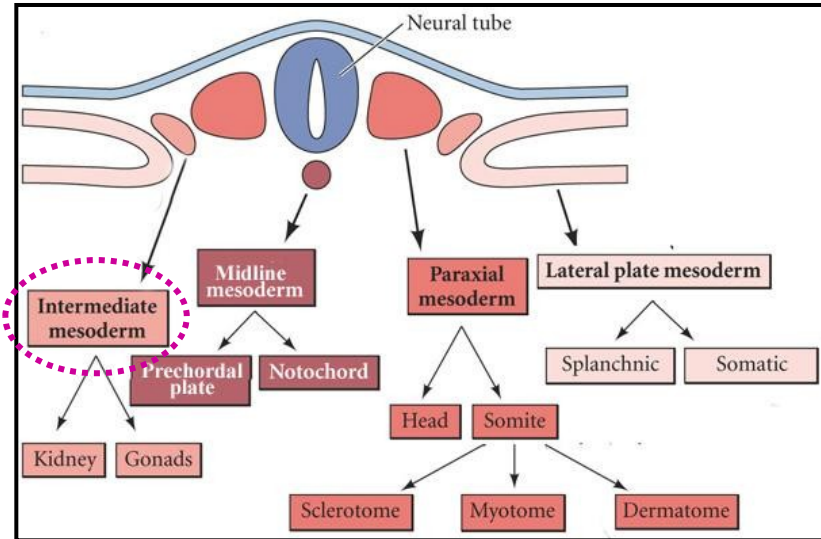
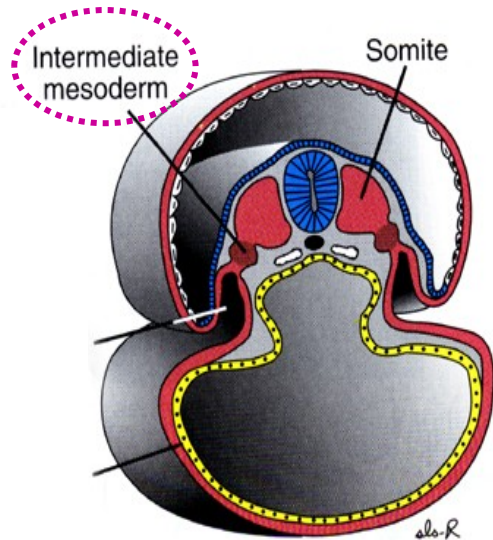
Močopohlavní systém - Celkový obraz



Močopohlavní systém - Připomenutí



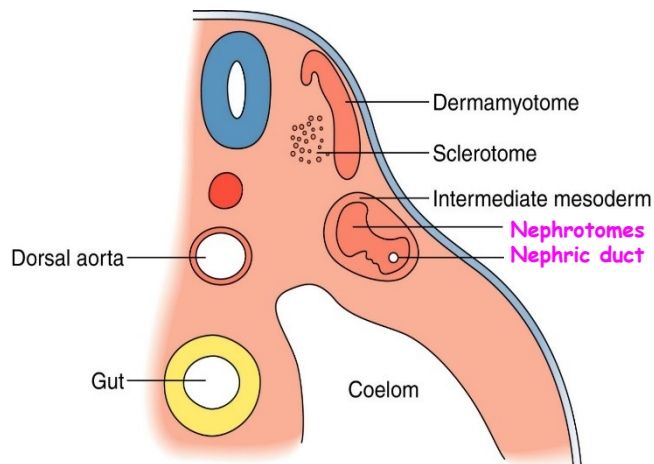
Močopohlavní systém - Intermediární mesoderm



Močopohlavní systém - Časné formy ledvin- Pronephros

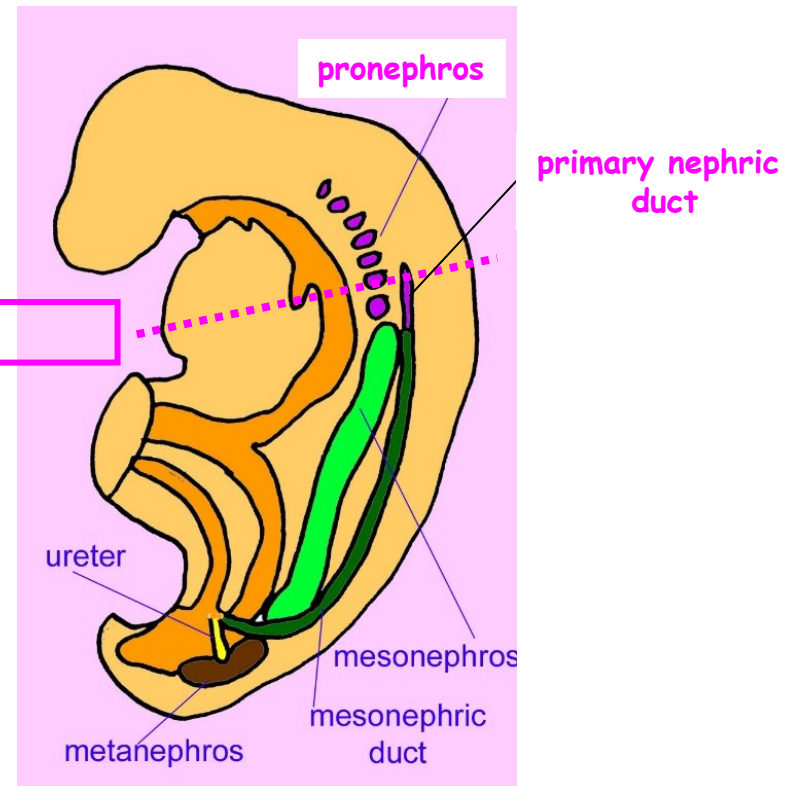
Recapitulation of three stages of evolution of kidneys in a cranial to caudal sequence:

- pronephros
- mesonephros
- metanephros



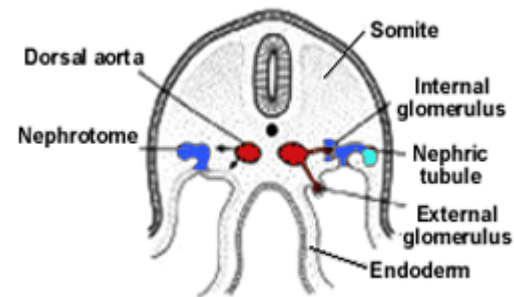
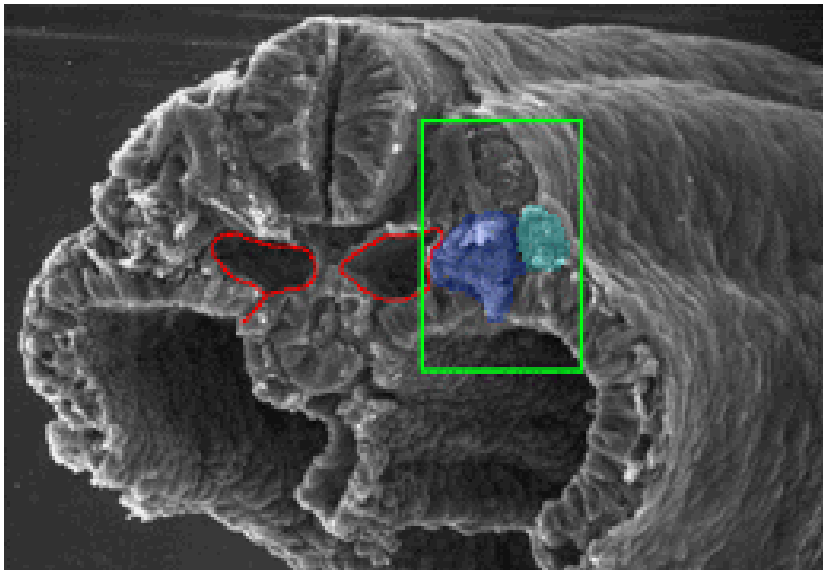
Nephrotomes

- at about day 22 in cervical part of nephrogenic cord
- 7 to 10 groups of epithelial cells
- connect to **primary nephric duct**
- non-functional
- disappear by day 28



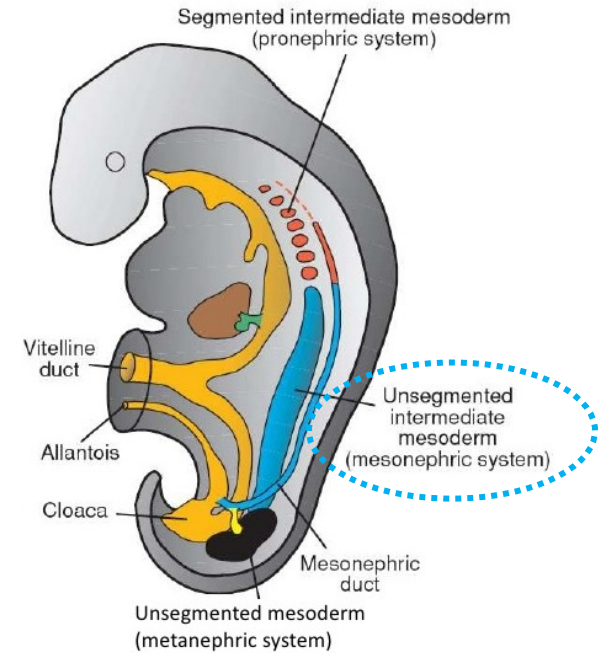
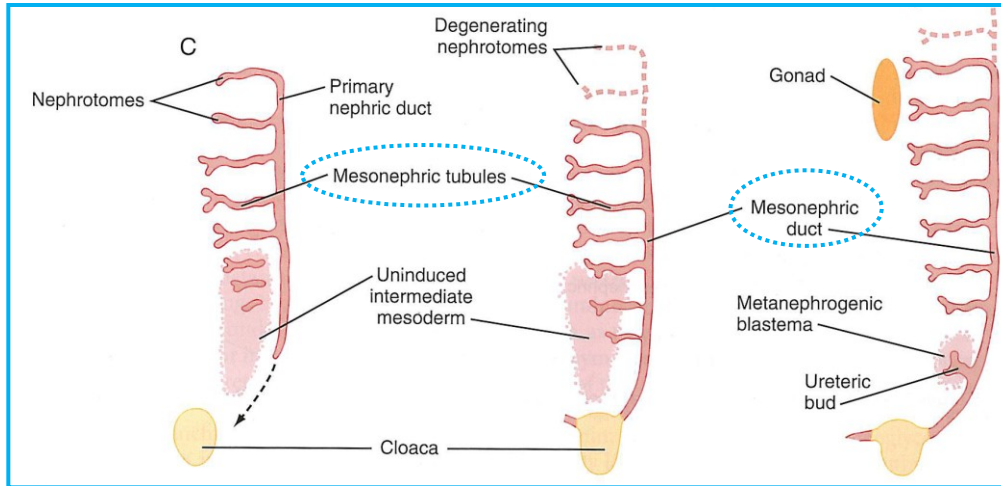
Močopohlavní systém - Časné formy ledvin- Pronephros

Mouse D9 - equivalent to human D27



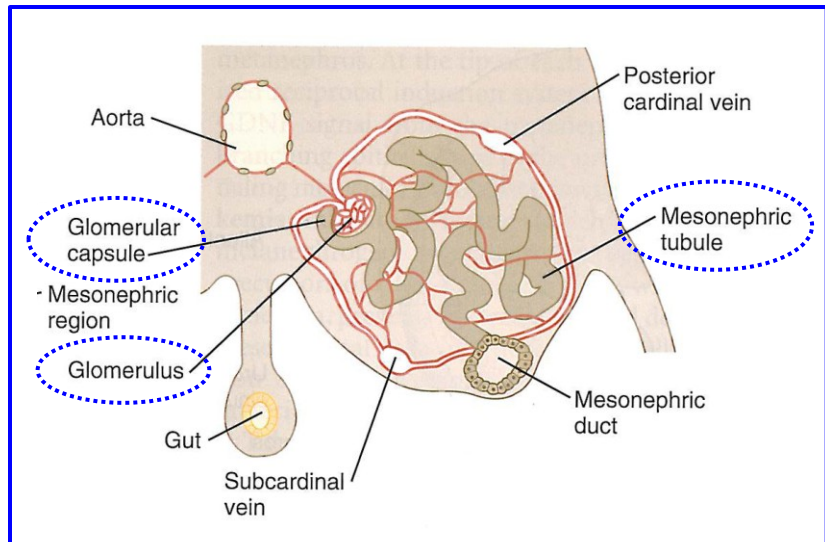
The lumen of each nephrotome opens into the primary nephric duct as well as into the body cavity. Glomeruli form as small vessels extend from the dorsal aortae.

Močopohlavní systém - Časné formy ledvin- Mesonephros

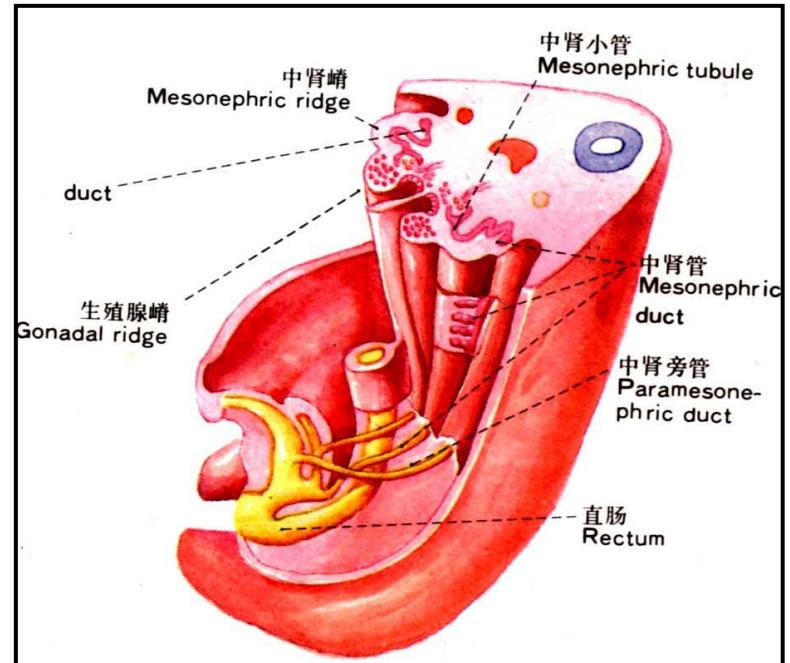
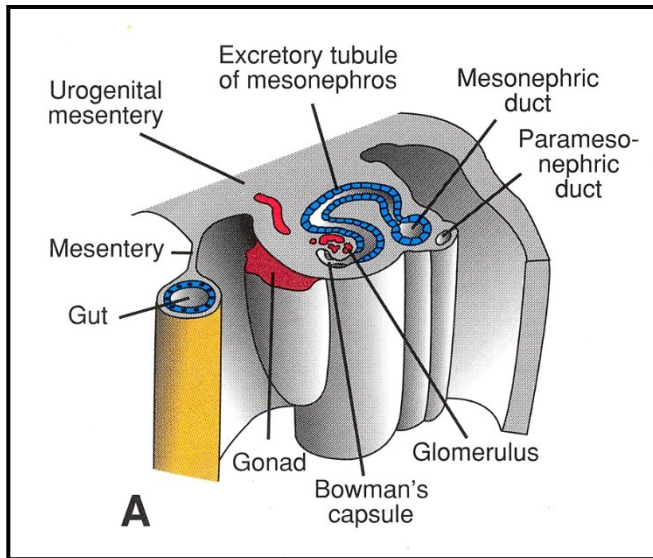


Mesonephros

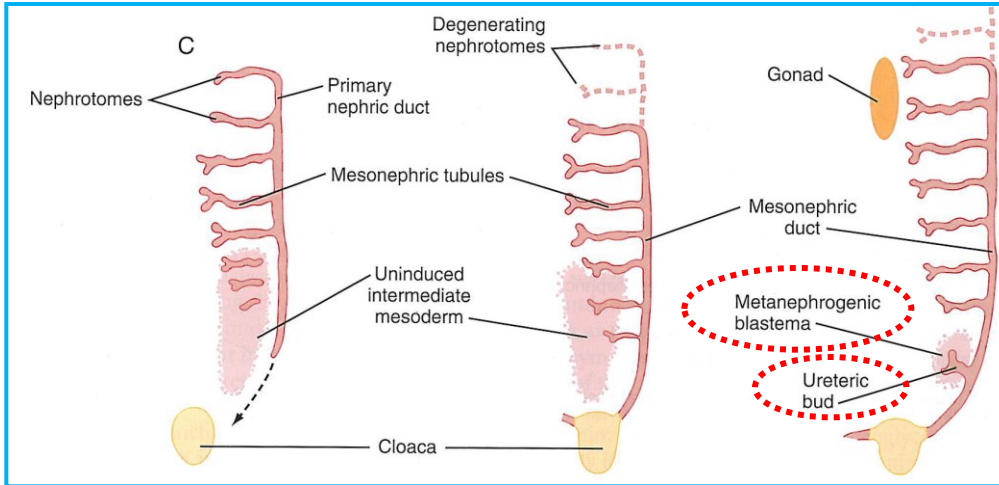
- caudal continuation of nephrogenic cord
- thoracolumbar region
- unsegmented intermediate mesoderm
- mesonephric ducts (paired) - Wolffian ducts
- **exkretční kanálky** - open individually into m. duct
- 36 to 40 m. tubuli in total (on one side)
- some filtration - **mesonephric unit** →
- mesonephros is most prominent when metanephros start to shape
- then they disappear fast
- mesonephric ducts persist in males



Močopohlavní systém - Mesonephros - Další pohled



Močopohlavní systém - Definitivní ledviny - Metanephros



Develop since week 5

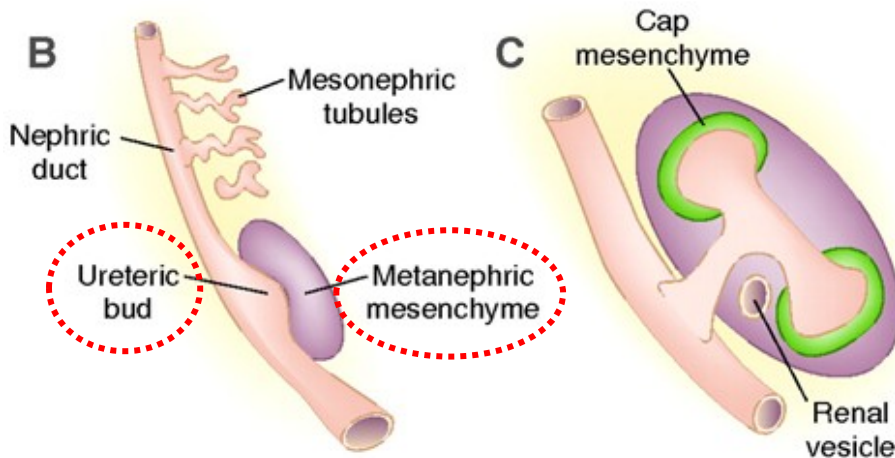
Ureterový pupen

+

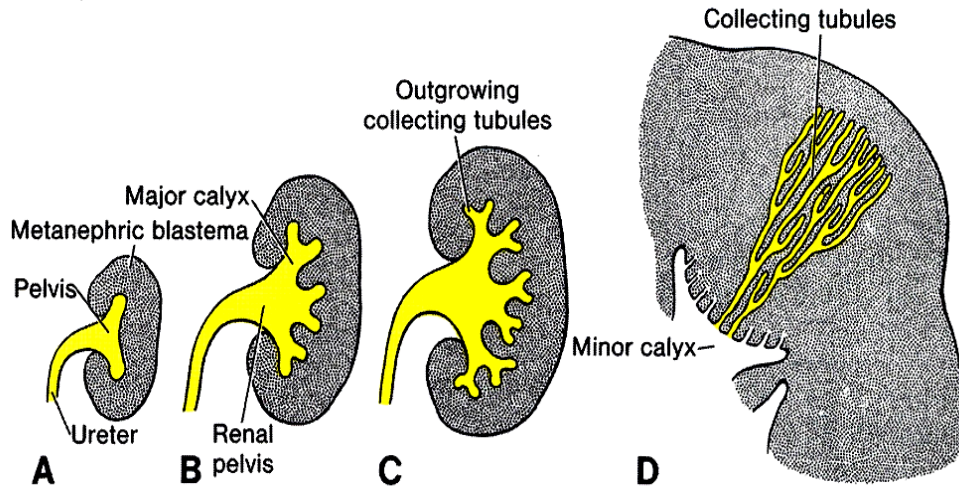
Metanephrogenní blastém
(mesenchyme)

Branching
and
Elongation

14 to 15 x



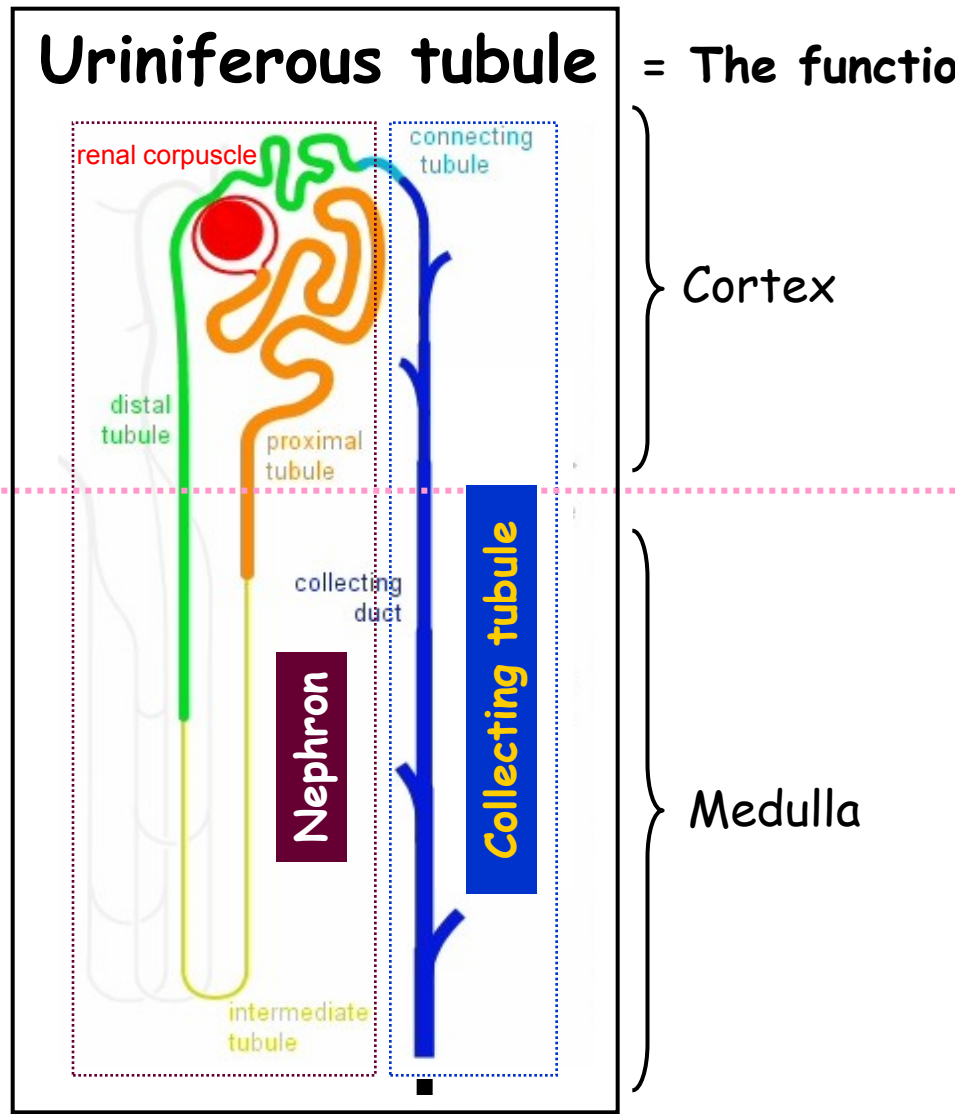
Močopohlavní systém - Definitivní ledviny - Metanephros



Opakované větvení ureterového pupenu:

- ureter
- pelvis
- calyces (major + minor)
- collecting tubuli (1 to 3 millions)

Urineriferous tubule = The functional unit of the kidney



Cortex

Medulla

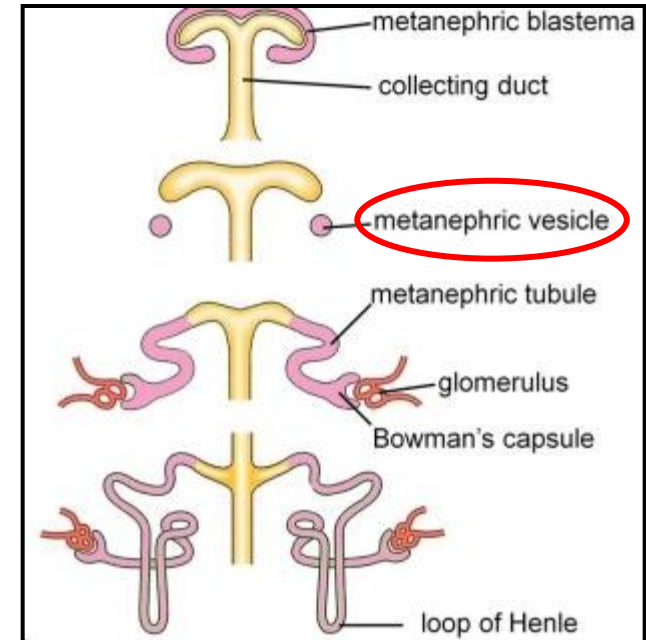
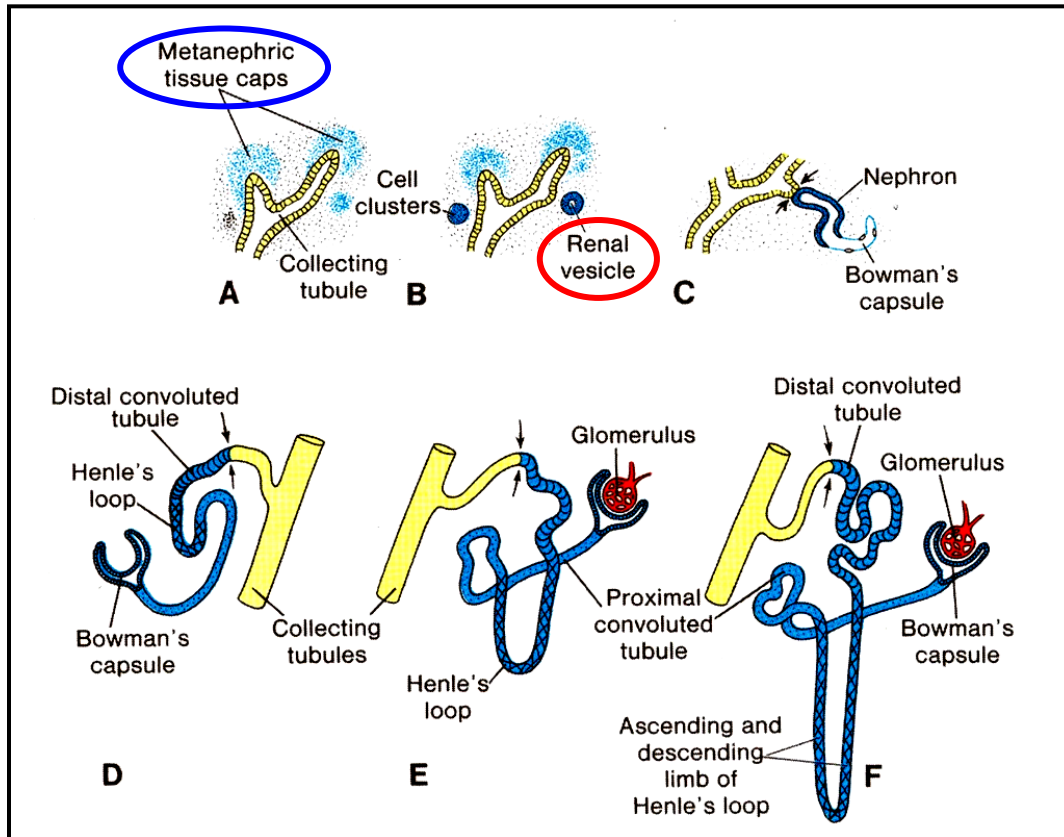
Ducts of Bellini

1 to 1.4 millions of nephrons in one kidney

Area cribrosa
Minor calyx

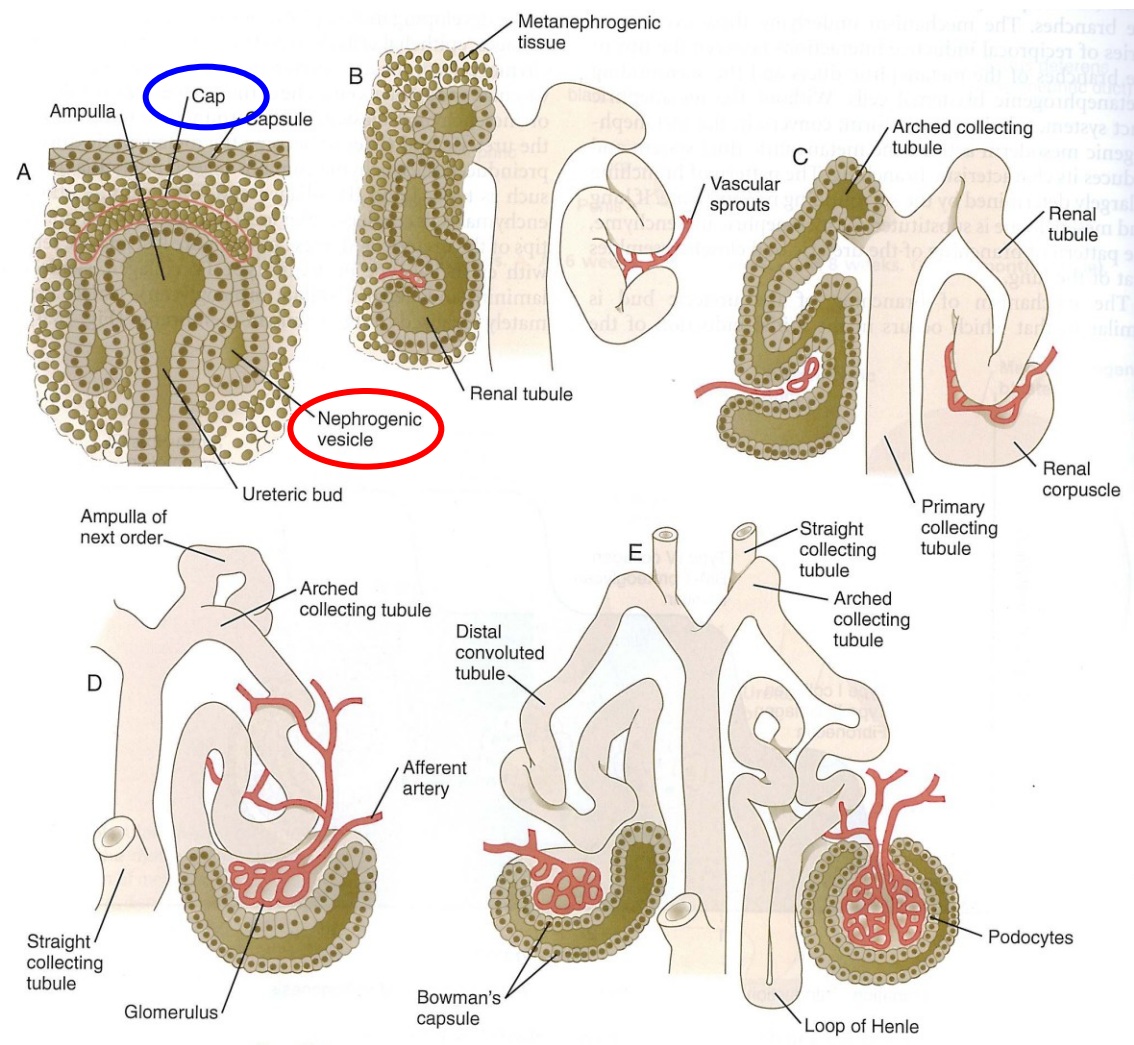
Nephrons X Collecting tubules
Different embryological origin

Močopohlavní systém - Metanephros - Nefrony

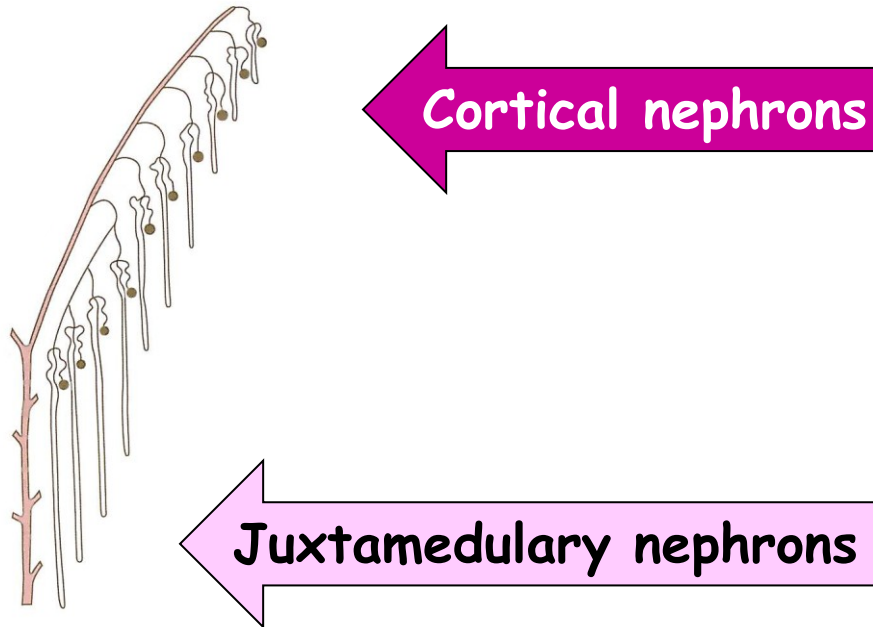


- arched ampulous endings of ureteric ducts (collecting tubuli) - **capping** by condensed mesenchyme
- part of the cap cells differentiate into **nephrogenic vesicle**
- vesicles elongate
- vesicles open to the collecting tubulus on one end
- distal from the ducts, the cells of elongating vesicles polarize and form **lumen and basal lamina**
- precursors of endothelia grow into this area - **glomerulus**
- endothelia connect to branches of dorsal aorta - **glomerular circulation**
- production of urine since week 10

Močopohlavní systém - Metanephros - Nefrony



Močopohlavní systém - Metanephros - Nefrony



- about 15 successive generations of nephrons in peripheral zone of kidney
- outermost nephrons are **less mature**

Močopohlavní systém - Definitivní ledviny - Metanephros

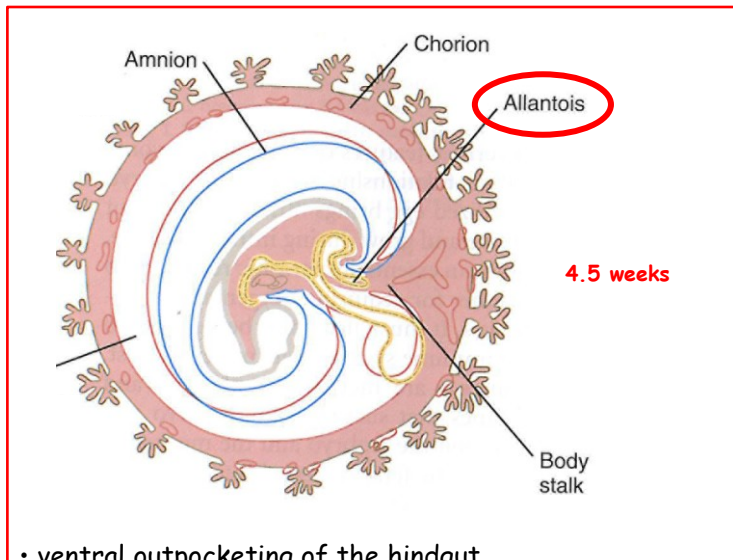


Močový systém - Měchýř

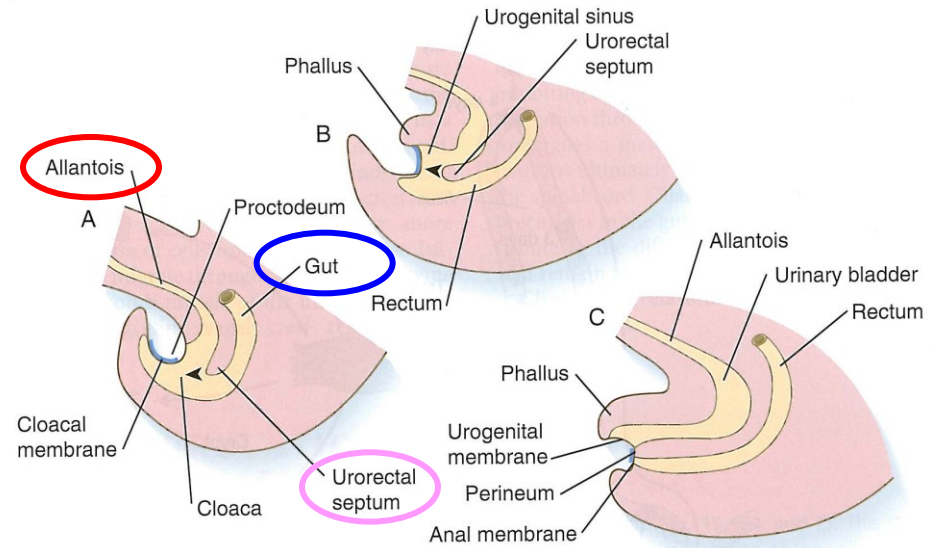
Kloaka

=

terminal part of the **zadní střevo** + **allantois**



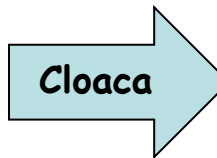
- ventral outpocketing of the hindgut
- sac-like structure (respiration)
- in umbilical cord
- proximal part - URACHUS - continuous with bladder
- URACHUS - transforme to Lig. umbilicale medianum



5 weeks

6 weeks

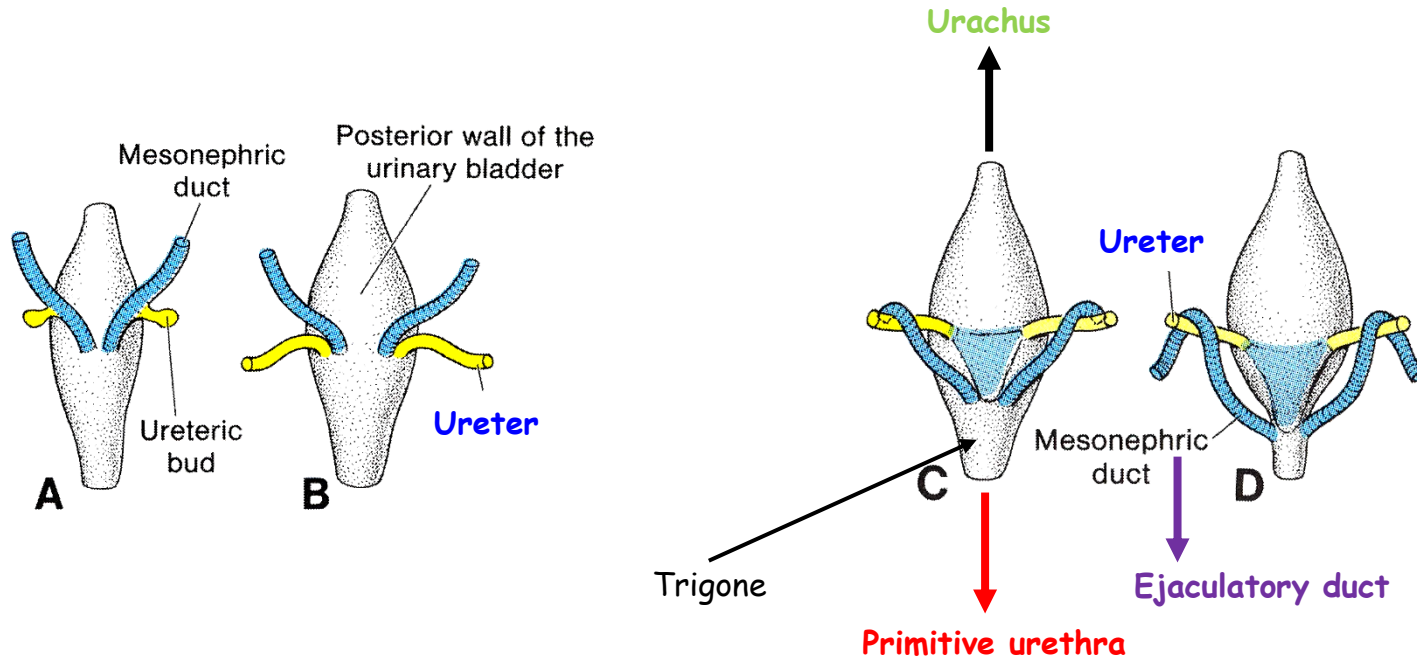
8 weeks



Simus urogenitalis	Membr. urogenitalis
Septum urogenitale	Perineum
Canalis analis	Membrana analis

Močový systém - Měchýř + Uretery + Uretra

Posterior view

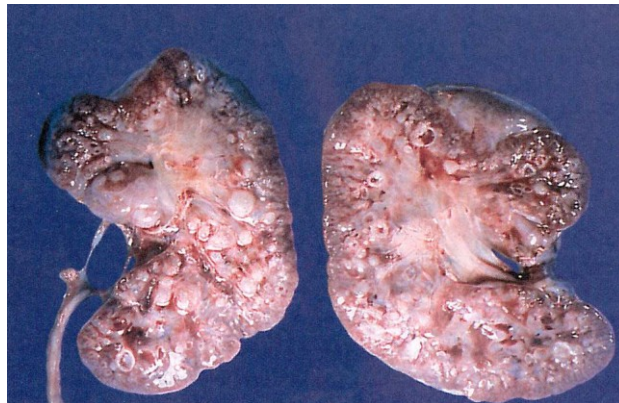


- alantoid expands - urinary bladder
- initially bladder is continuous with alantoid - then obliteration - **urachus** - **Lig. umbilicale medianum**
- caudal portions of mesonephric ducts become absorbed by the bladder wall - separation - **ureters** + **ejaculatory ducts**

Močový systém - Vrožené anomálie

1. Agenesis
2. Duplication
3. Anomalies of shape
4. Abnormal of position
5. Congenital polycystic kidney

Horseshoe kidney

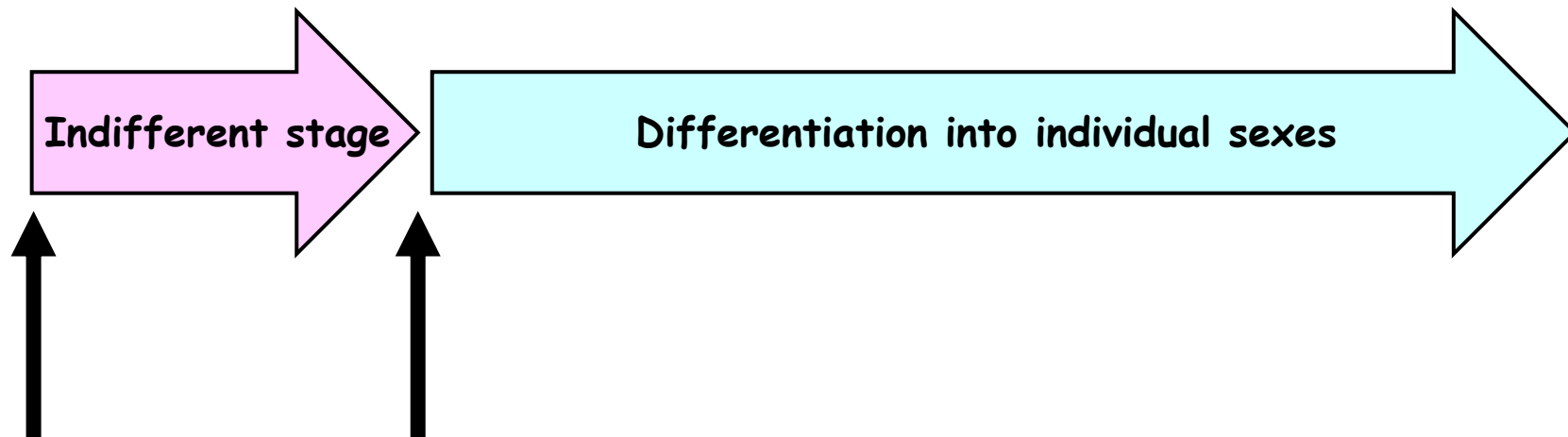


Pohlavní systém

Pohlavní dimorfismus - individual can only have one type of genital organs

Genetic determination:

- Heterogametic (XY) - male
- Homogametic (XX) - female



Fertilization

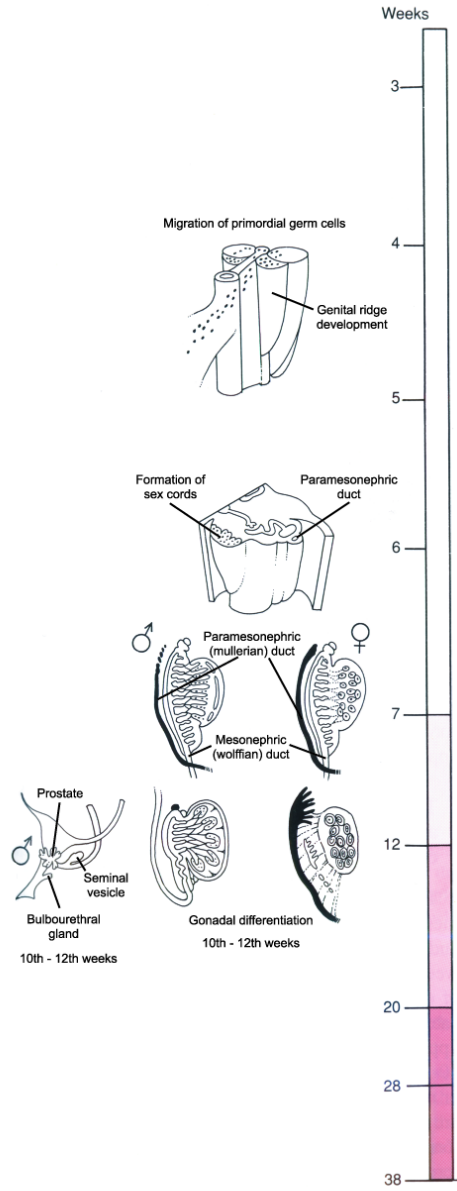
7th week

=

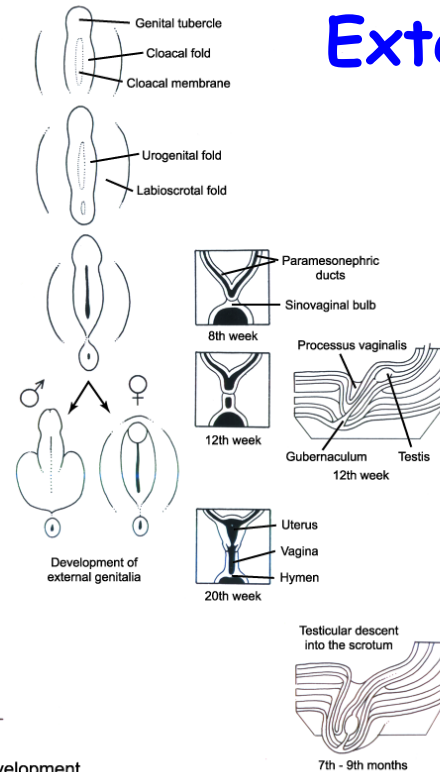
genetic gender established
(Barr body)

Pohlavní systém - 7 weeks at indifferent stage

Gonads



External genitalia

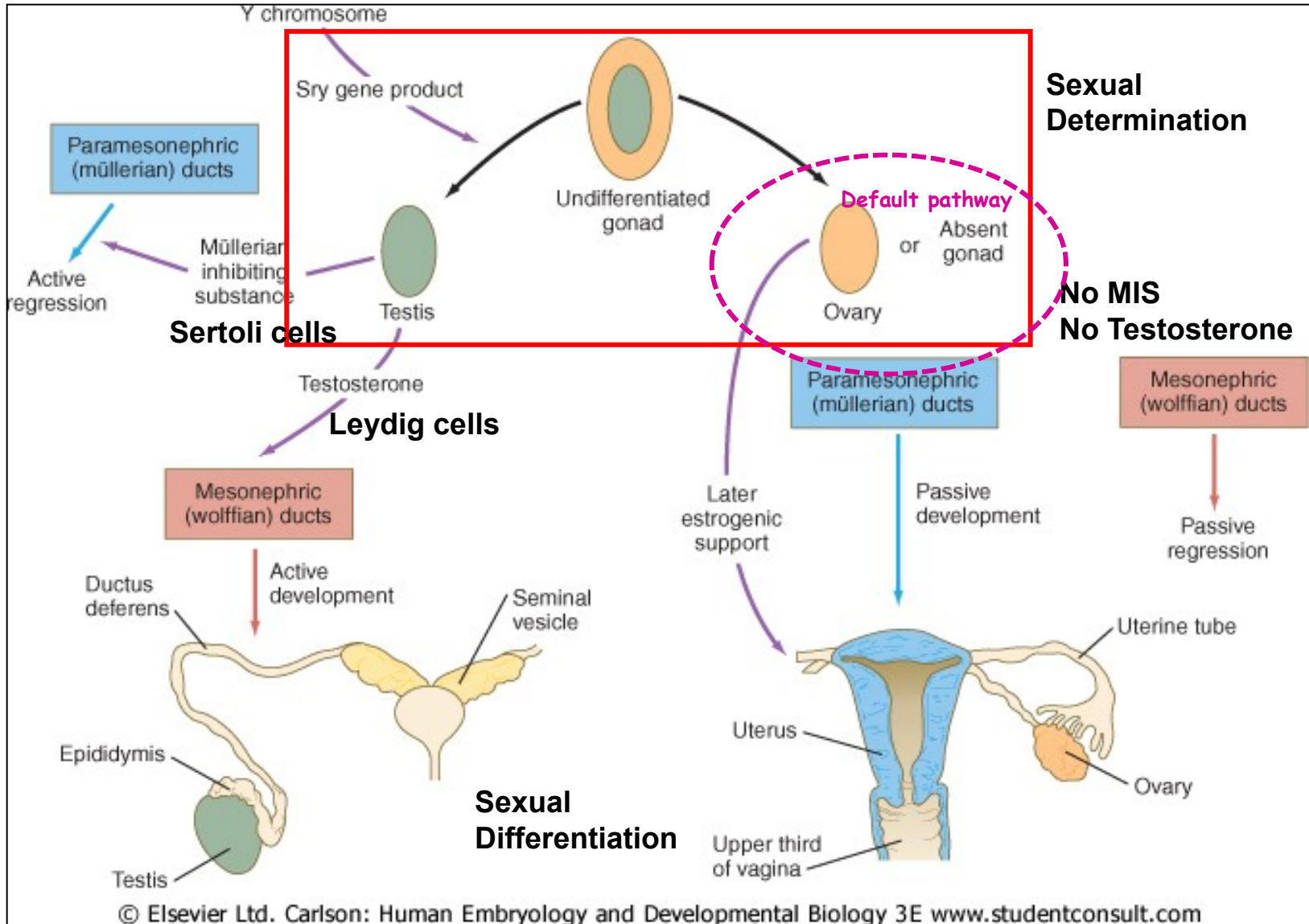


C. Genital development

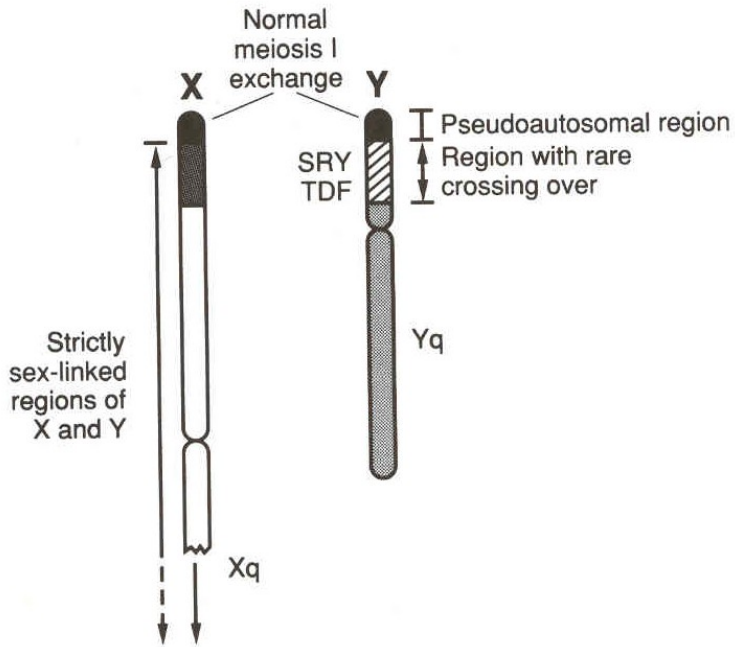
Pohlavní systém - Sry gen

Y chromosome decides
 XXY - male
 XO - female

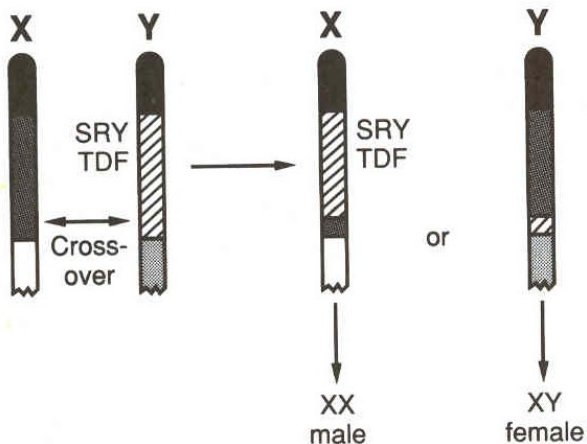
Sry gene - Sox family TF - on short arm of Y chromosome



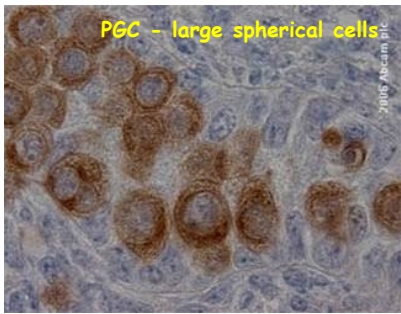
Pohlavní systém - Sry gen



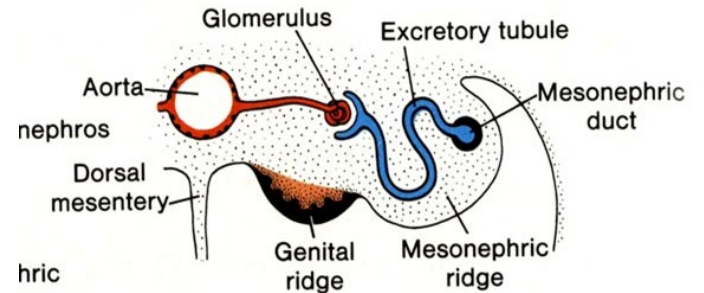
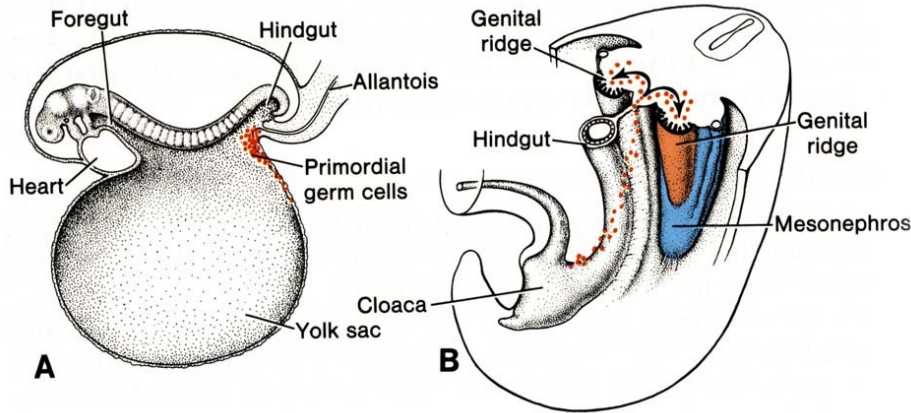
Pairing of X and Y chromosomes in pseudoautosomal region during meiosis



Rare crossing-over causes translocation of SRY to X chromosome:
XY females or XX males

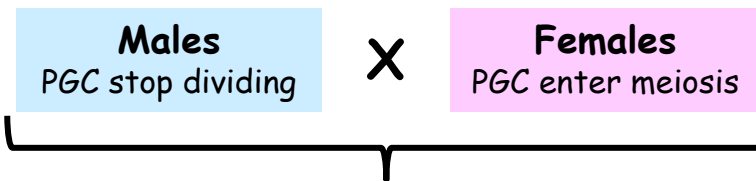


Pohlavní systém - Primordiální germinální buňky



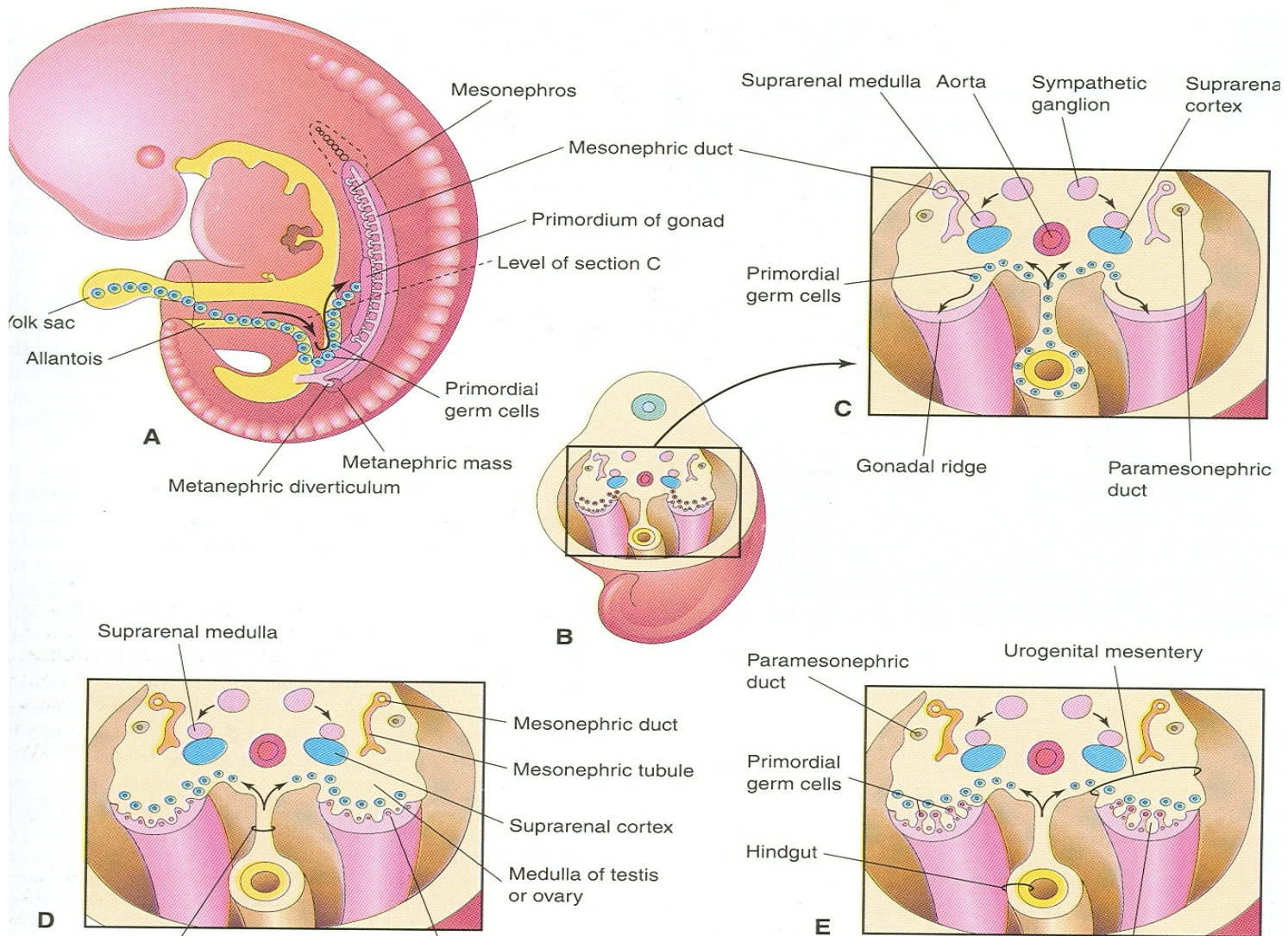
Primordial germ cells (PGC)

- first recognizable at day 24
- from epiblast-derived extraembryonic mesoderm
- few cells among endodermal cells of the yolk sac
- they migrate through the dorsal mesentery of the hindgut
- migrate towards genital ridges (plicae genitales)
- proliferate during migration
- reach (1-2 thousands) genital ridges on week 6 of gestation



decided by somatic cells in the genital ridges

Pohlavní systém - migrace PGC do základů gonád



Pohlavní systém - základ gonád

Steroidogenní mesoderm
along the ventromedial border of the mesonephros

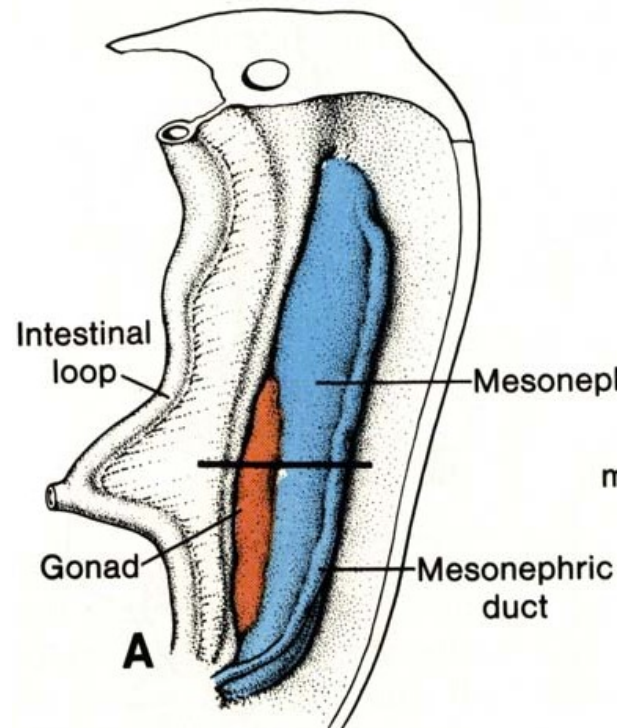
Kraniální oblast
Adrenocortical primordia

Kaudální oblast
=
Pohlavní lišty

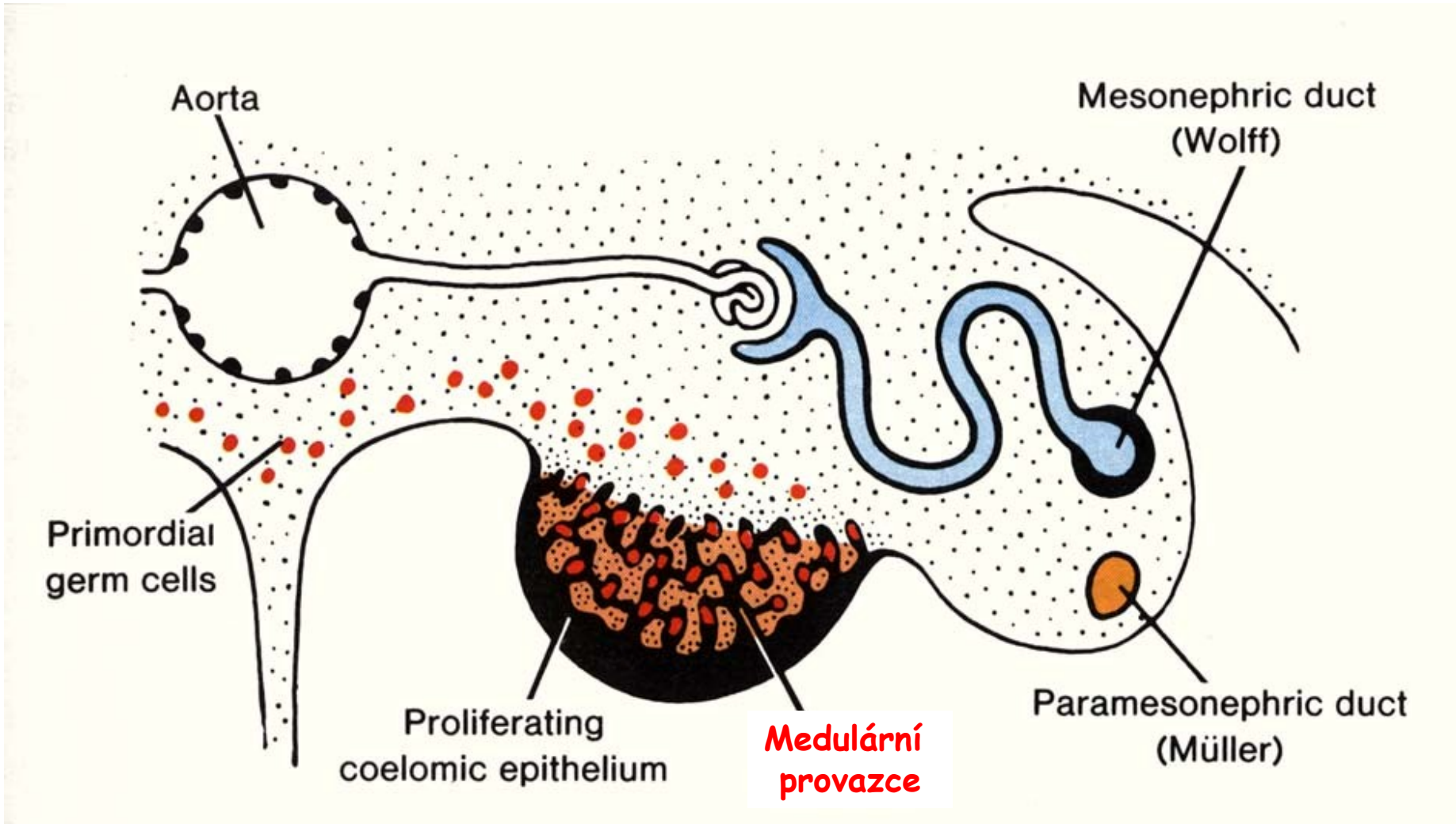
cells of **coelomic epithelium**
+
cells from **mesonephric ridge**

Week 4 - Th6 to S2
cranial + caudal parts involute
Week 6 - L3 to L5

become populated by PGC at week 6



Pohlavní systém - indiferentní gonáda (týden 6)



Pohlavní systém - Diferenciace varlat

Late 6th week

Cord cells differentiate to Sertoli cells

(meiosis-inhibiting factor, anti-mullerian substance, androgen binding factor)

Tunica albuginea develops

(sets barrier between coelomic epithelium and testis cords)

Cord cells form seminiferous tubuli, tubuli recti, and rete testis

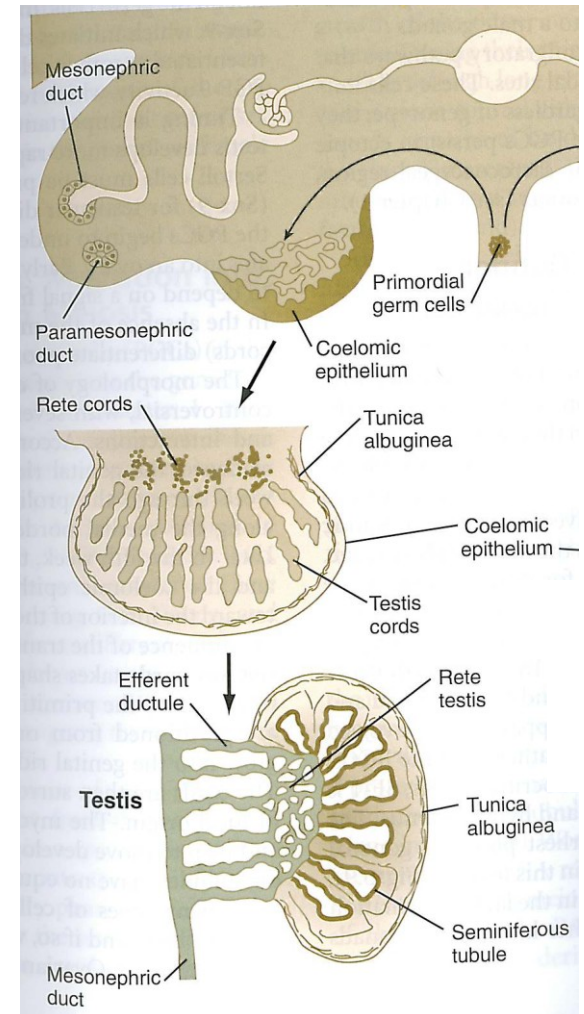
Rete testis joins ductli efferentes that are derived from mesonephric ducts

(5th to 12th)

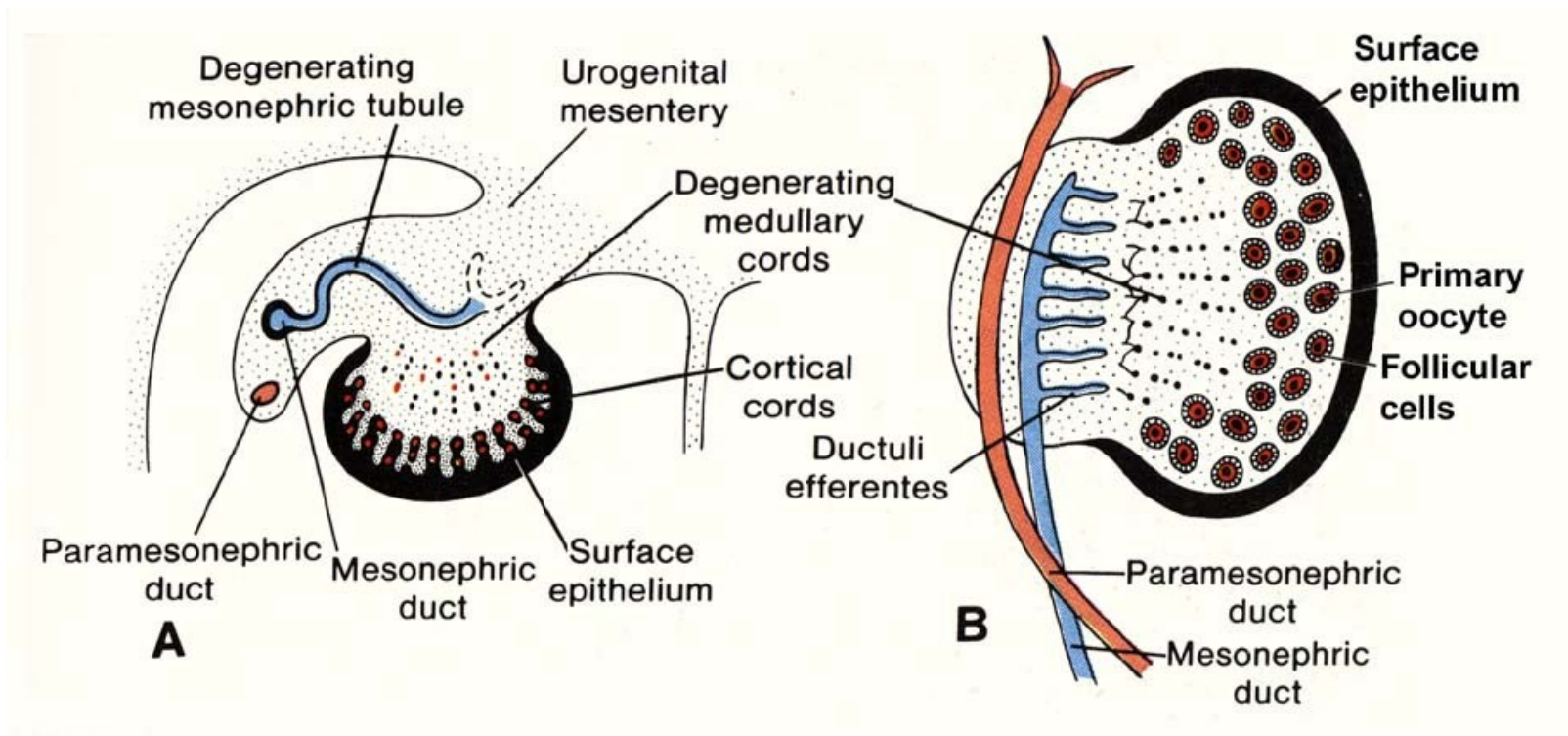
Week 8 to 18

Leydig cells develop and function in developing testis

- from coelomic epithelia and mesonephros
- produce testosterone
- support development of Wolfian (mesonephric) duct
- support development of external genitalia



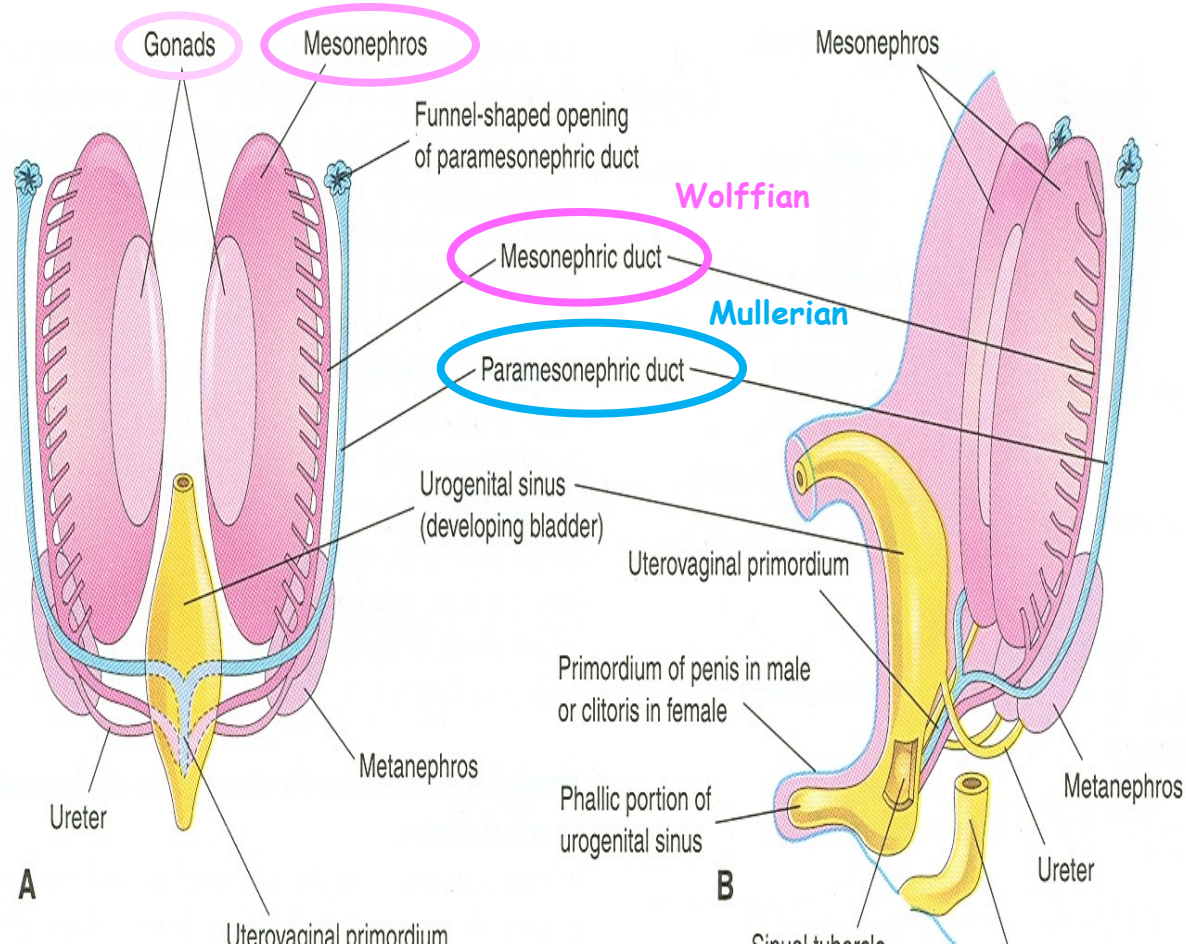
Pohlavní systém - Diferenciace vaječníků



- PGC concentrate in the cortical region
- PGC proliferate (max until week 22) and then enter meiosis - arrest in prophase
- Ovarian follicles develop
(somatic cell contribution is not understood)
- Transient rete ovarii develops in medullary region
- Medulla contains connective tissue and vasculature derived from mesonephros

Pohlavní systém - Vývodné cesty - Indiferentní stádium

Week 7

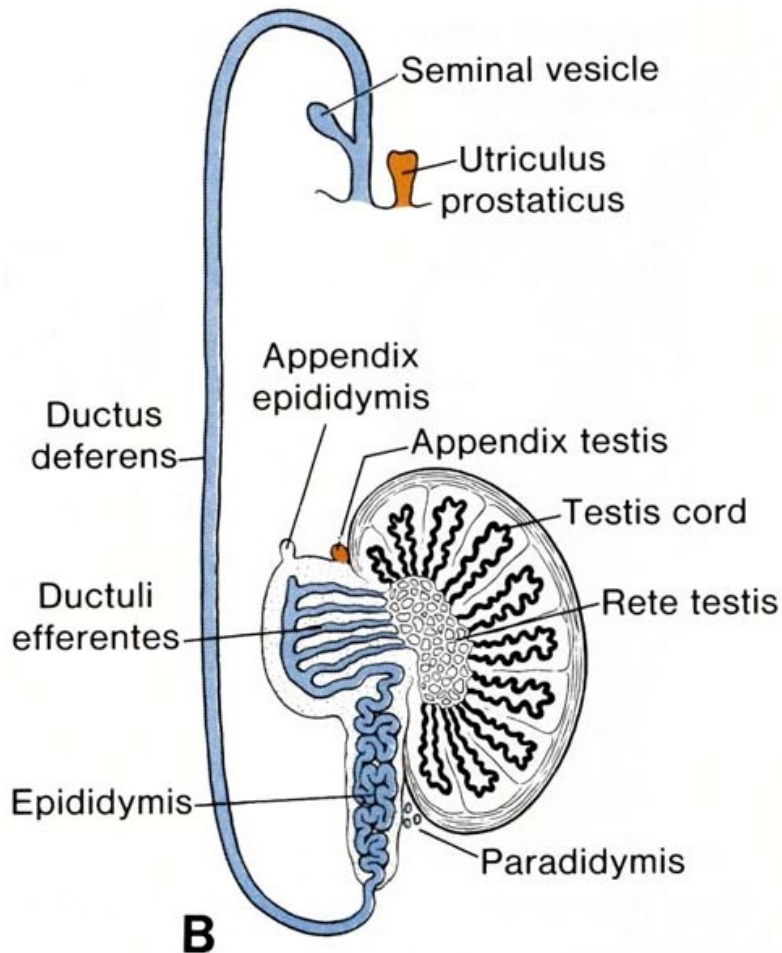


Paramesonephric duct

Develops at days 44 to 48

Cranially opens to coelomic cavity

Pohlavní systém - Vývodné cesty - Muži



Mesonephric ducts (Wolffian)

- Ductus epididymis
- Ductus deferens
- Ductus ejaculatorius
- Seminal vesicle

Paramesonephric ducts (Mullerian)

regresses in week 8 (anti-M hormone)

- Appendix testis (cranial part)
- Utriculus prostaticus (caudal part)

Mesonephros

- Ductuli efferentes
- Paradidymis (under the testis, nonfunctional)

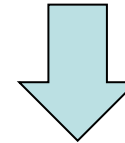
Pohlavní systém - Sestup varlat

„Prerequisites + driving forces“ for the descent of testes:

- testes enlargement
- atrophy of mesonphros - allows for caudal movement
- tension of gubernaculum
- atrophy of paramesonephric ducts - move to unguinal canal
- enlargement of processus vaginalis peritonei (6th month)
- increased intraabdominal pressure ?

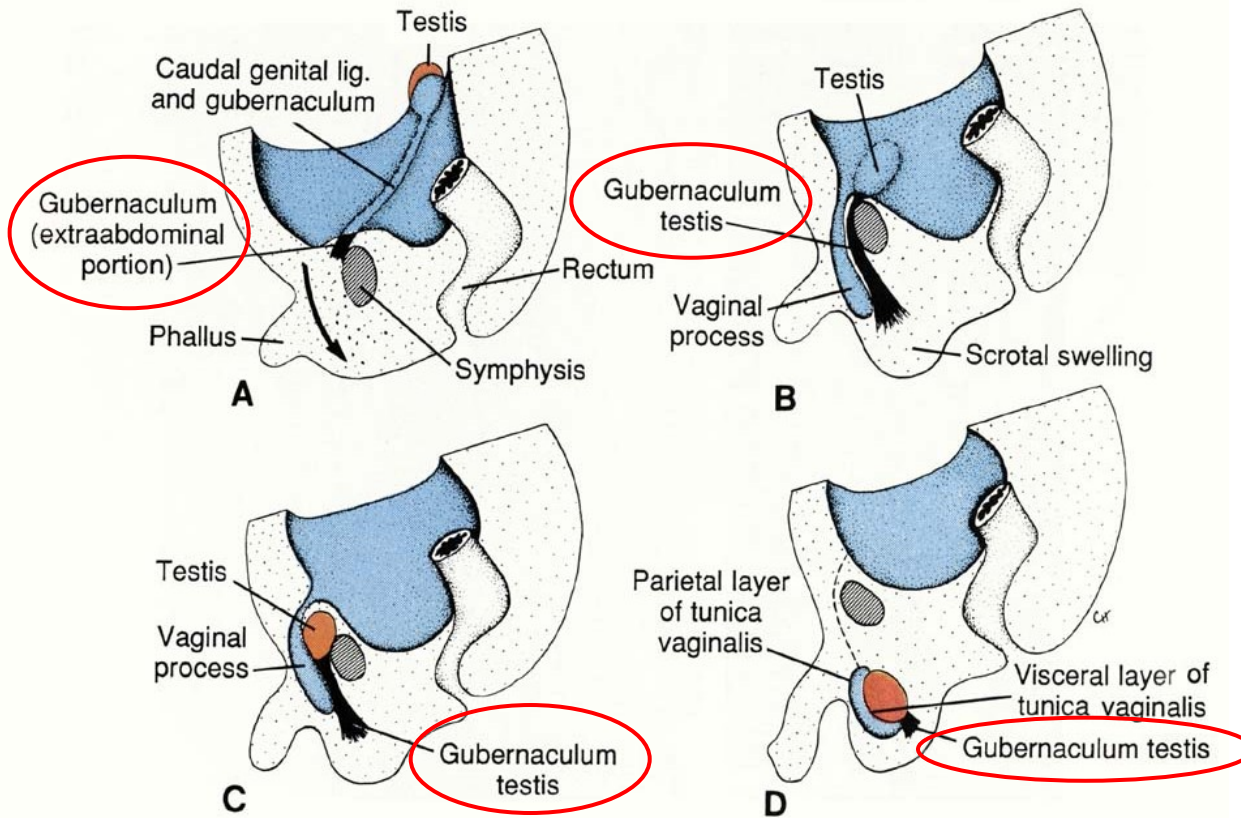
By 26 weeks

- the testes have descended retroperitoneally to the deep **inguinal rings**



During 26th week

- final descent through the **inguinal canals** into the scrotum - 2 to 3 days



NOTES

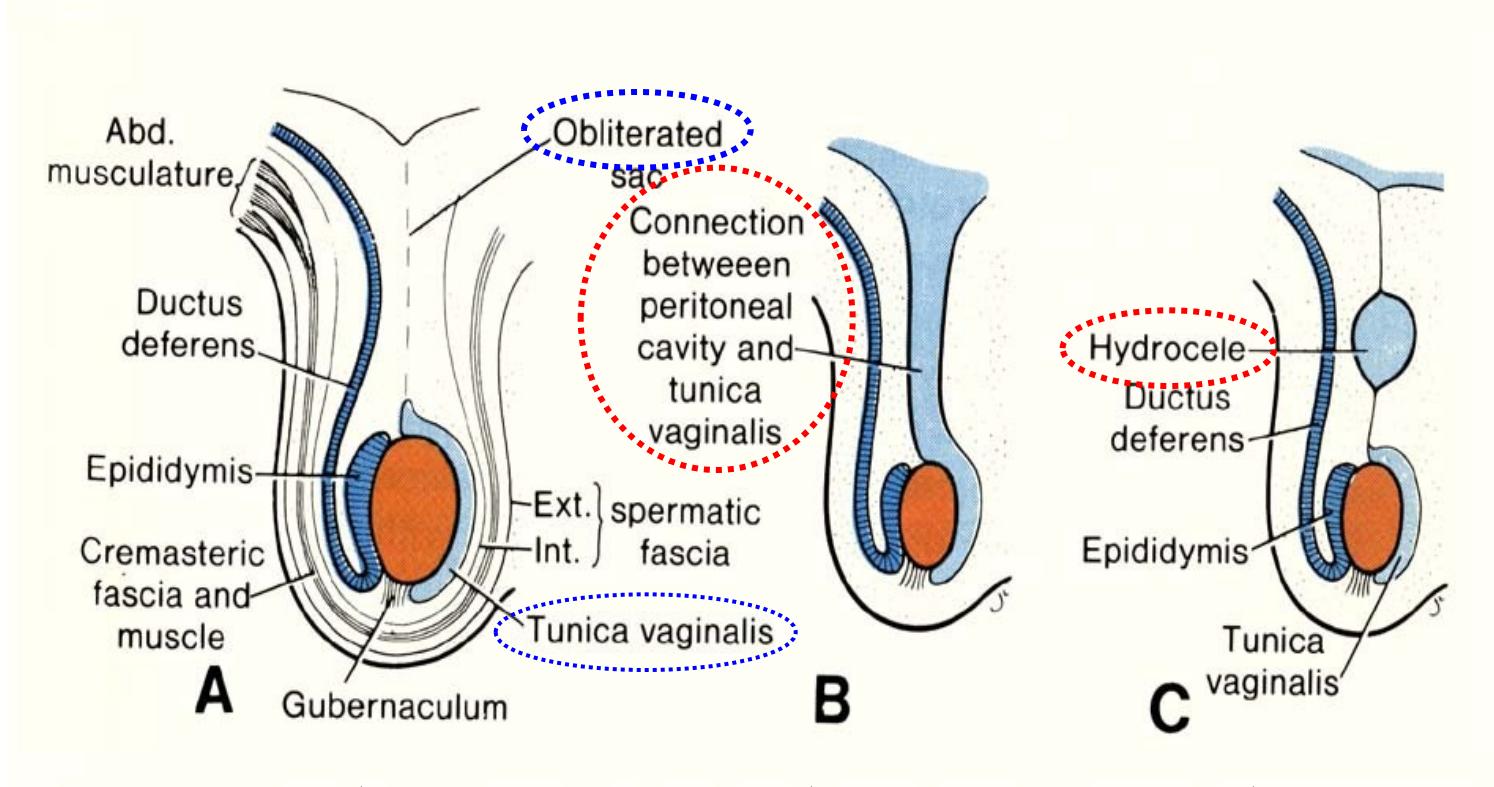
More than 97% of full-term newborn males have both testes in the scrotum

During the first 3 months after birth, most undescended testes descend into the scrotum

Spontaneous testicular descent does not occur after the age of one year

Gubernaculum - originates from caudal portion of genital ridge

Pohlavní systém - Sestup varlat

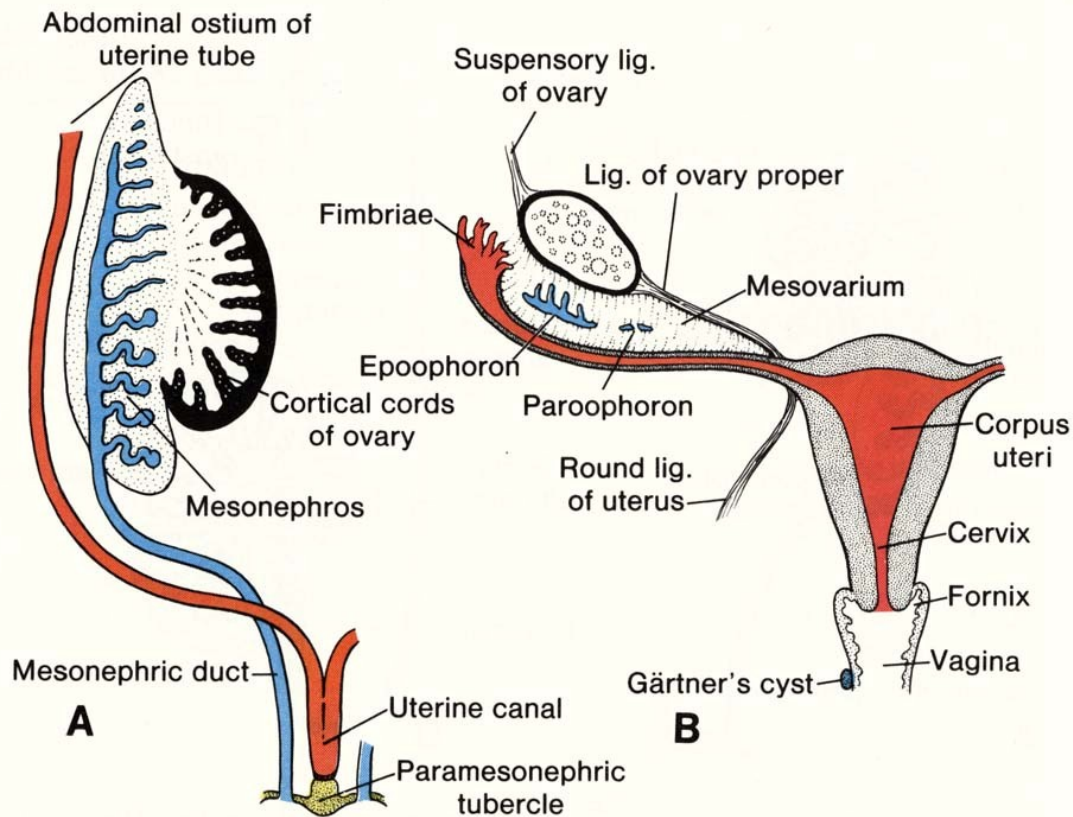


Processus vaginalis obliterated
NORMAL

Remaning connection
ABNORMAL

Remaing cyst = Hydrocele
ABNORMAL

Pohlavní systém - Vývodné cesty - Ženy



Mesonephric ducts (Wolffian)

regresses (absence of testosterone)

- Gartner's cyst (caudal part)

Paramesonephric ducts (Mullerian)

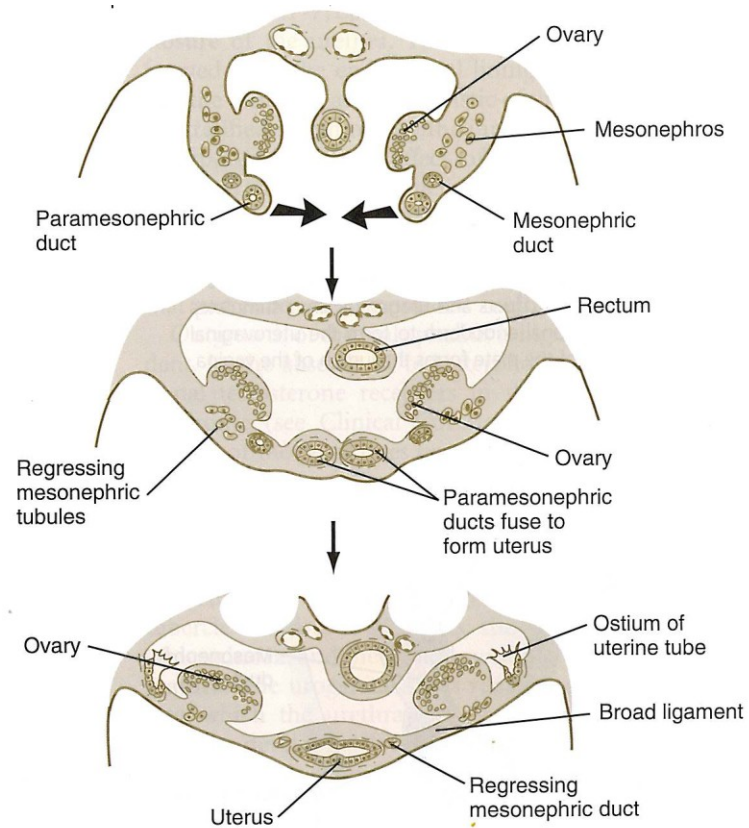
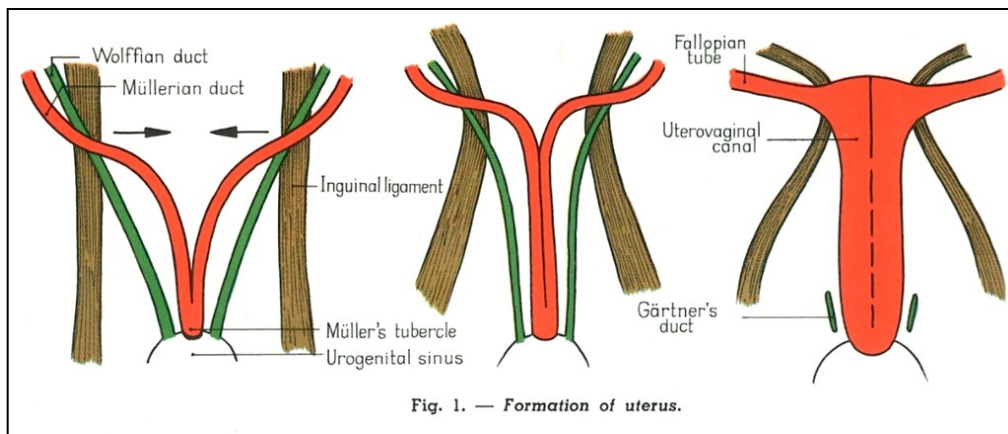
involutes in week 8

- Uterine tubes (falopian t.)
- Uterus
- Vagina

Mesonephros (+Mesonephric duct)

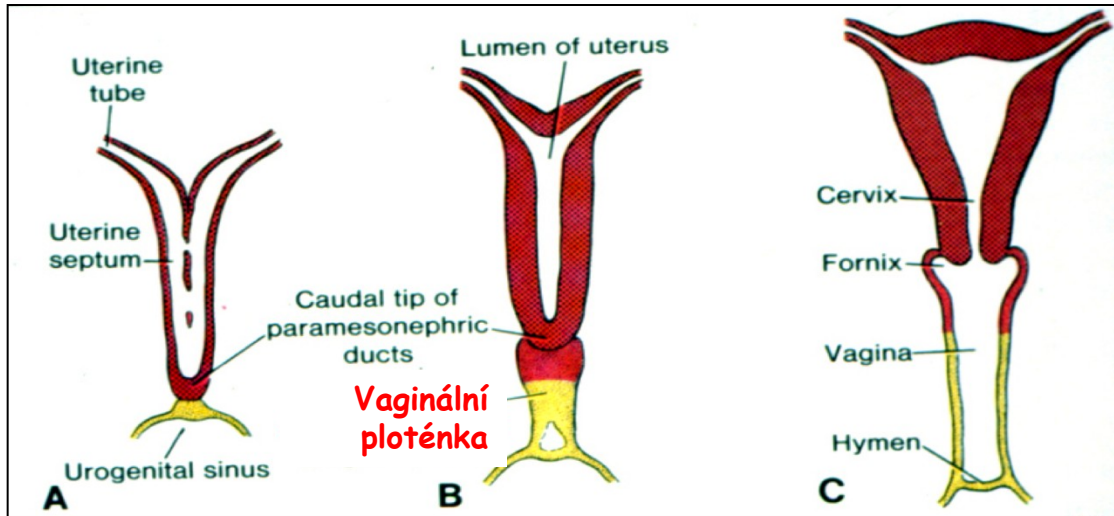
- Epoophoron (appendix of ovary)
- Paraophaoron

Pohlavní systém - Vývodné cesty - Ženy

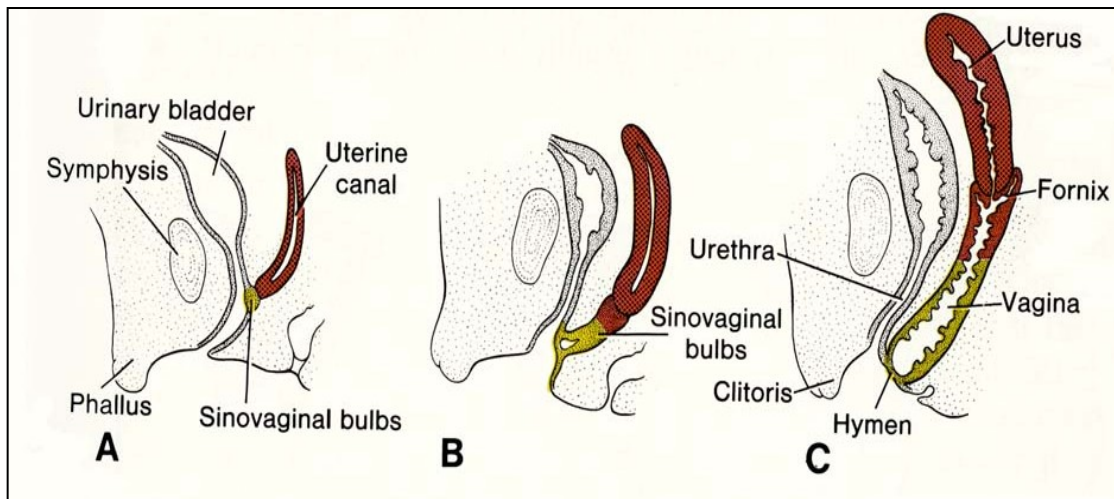


Pohlavní systém - Vývodné cesty - Ženy

Dorsal view

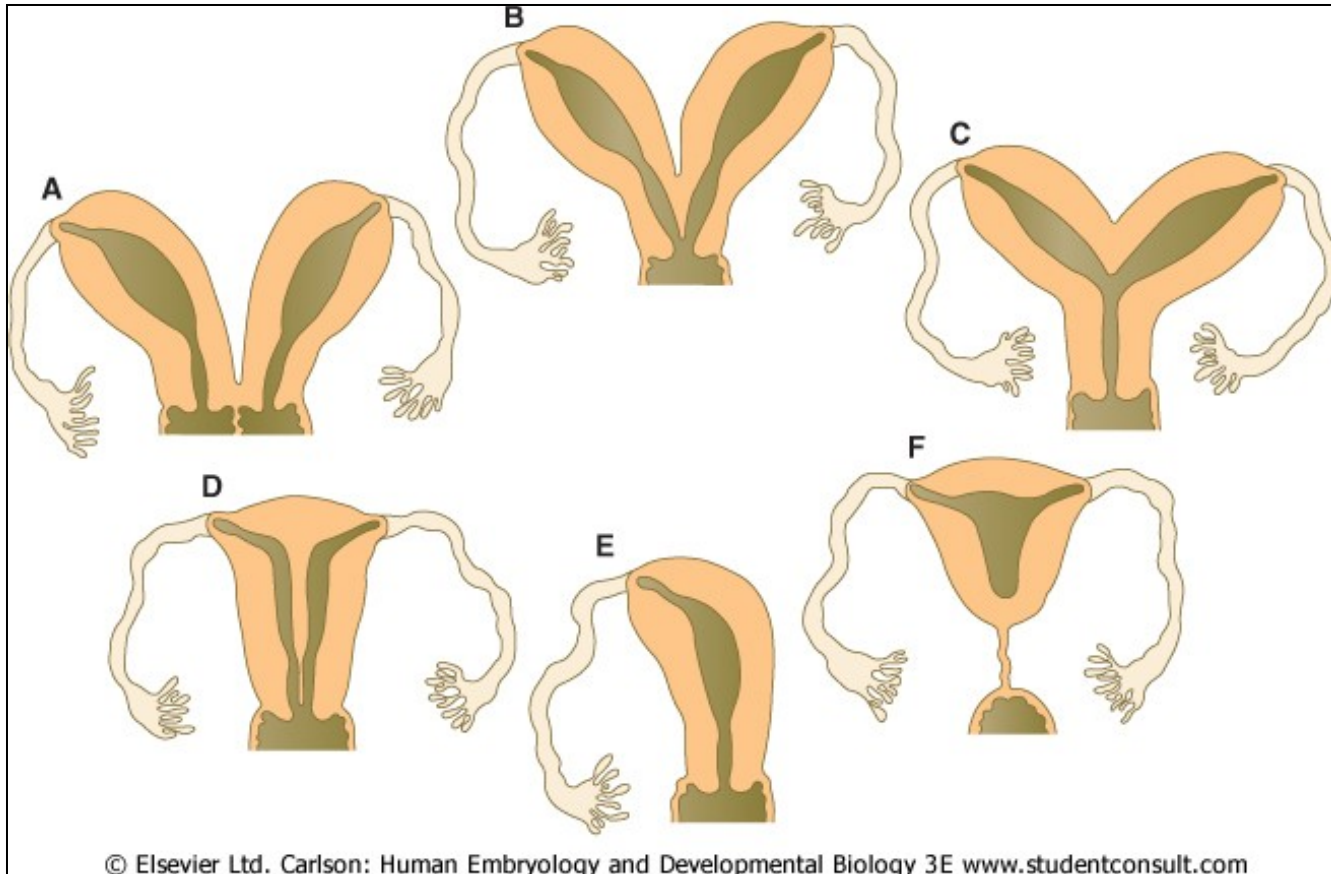


Lateral view



Paramesonephric (Mullerian) ducts fuse to form uterus and upper 1/3 of vagina

Pohlavní systém - Vývodné cesty - Anomálie

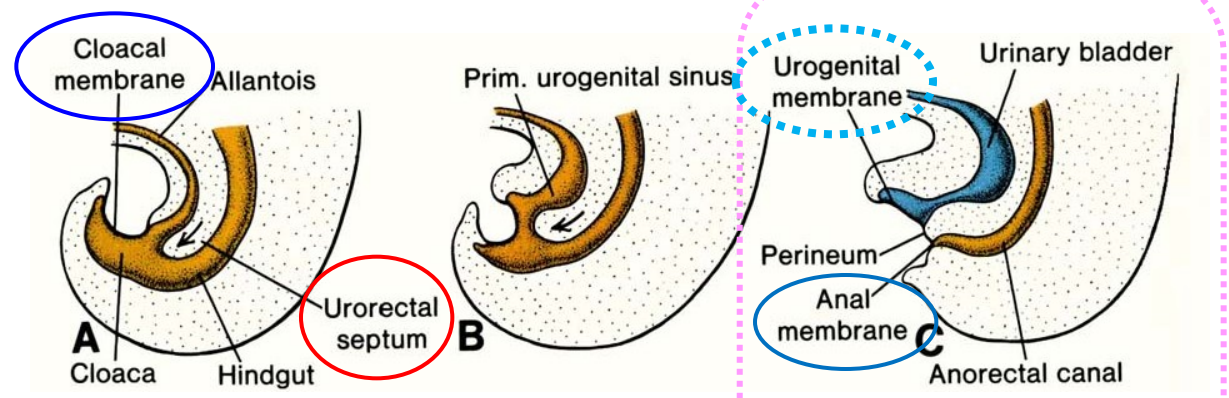


Pohlavní systém - Zevní pohl. orgány - Indiferentní stádium

They are derived from a complex mesodermal tissue located around cloaca.

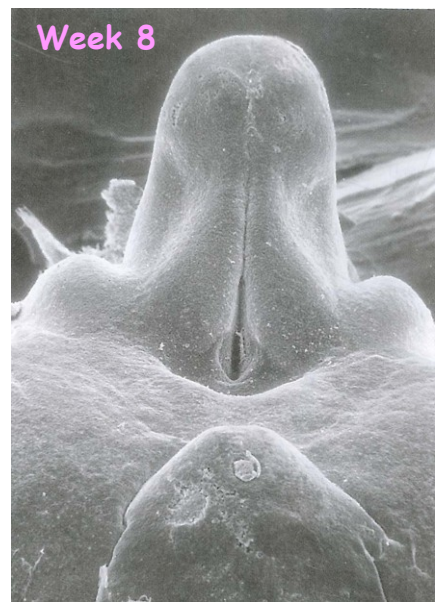
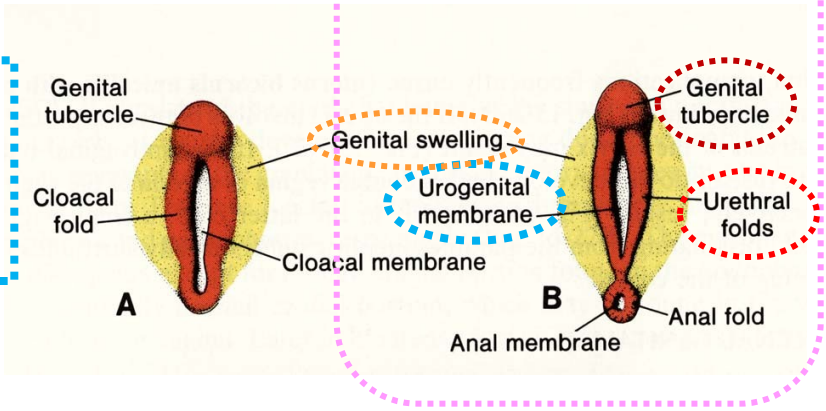
HORMONE-INDEPENDENT

Week 6 to 8

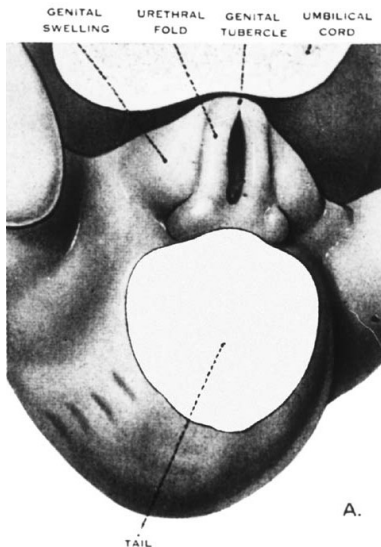
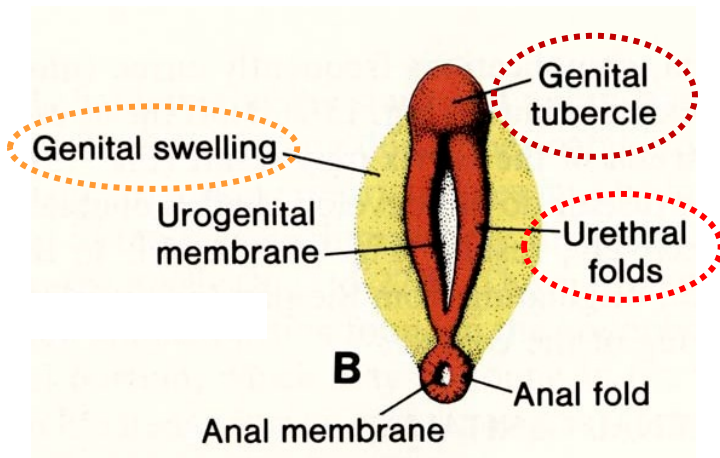


Orificium urogenitale primitivum
ohraničeno:

Genitální výběžek - Phallus
 Uretrální řasy - Plicae urogenitales
 Genitální valy - Tori genitales

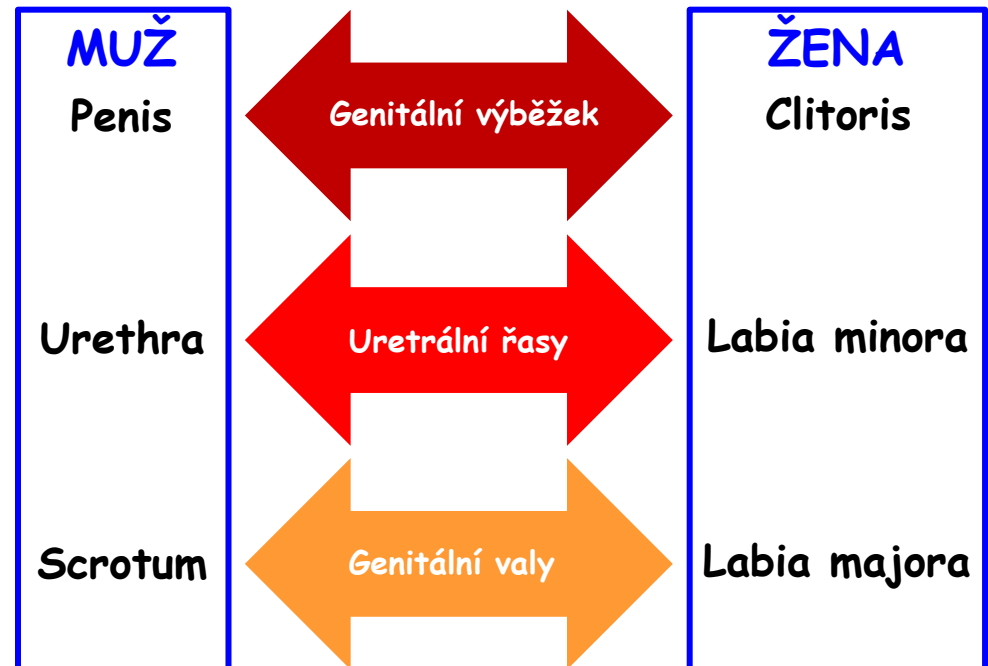


Pohlavní systém - Zevní pohl. orgány - dimorfismus



Week 9 to 13

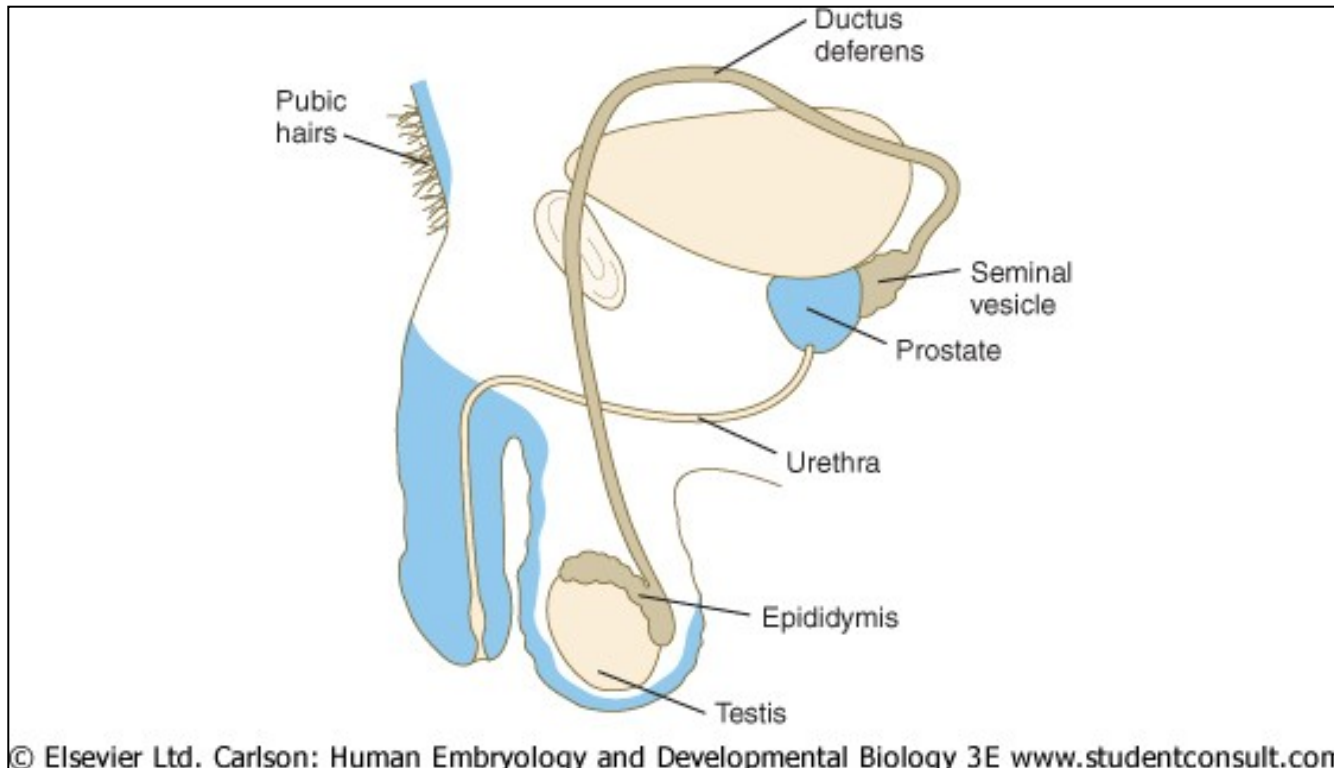
Weeks 12 + 13 are particularly critical
=
fúze uretrálních řas



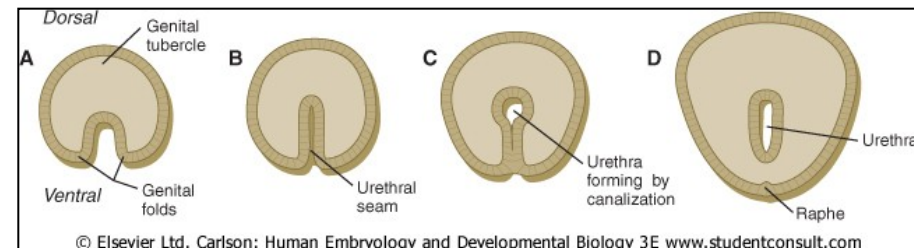
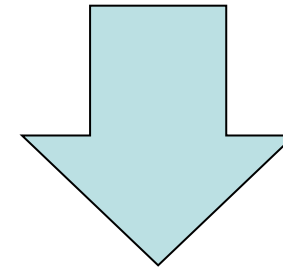
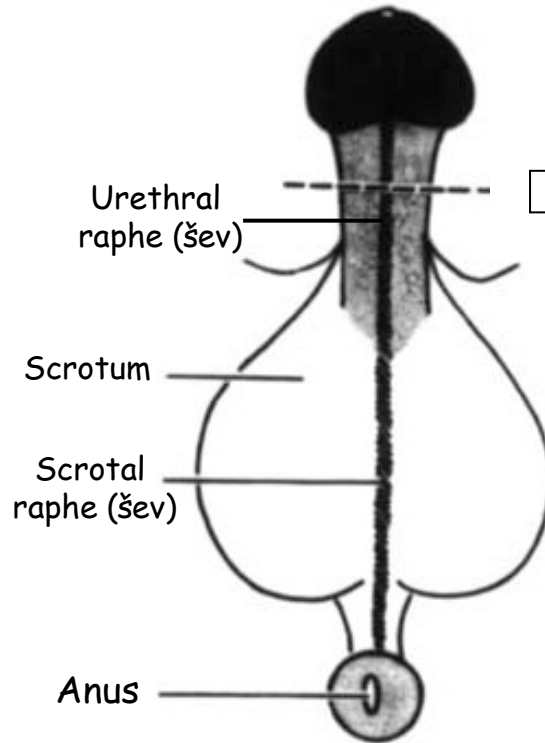
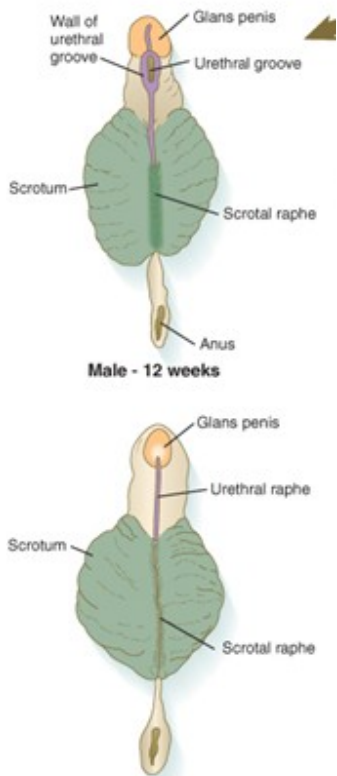
Pohlavní systém - Zevní pohl. orgány - Muži

Influenced by dihydrotestosterone

Influenced by testosterone



Pohlavní systém - Zevní pohl. orgány - Muži



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Genital tubercle elongates - penis (phallus)

Genital swellings enlarge - scrotum

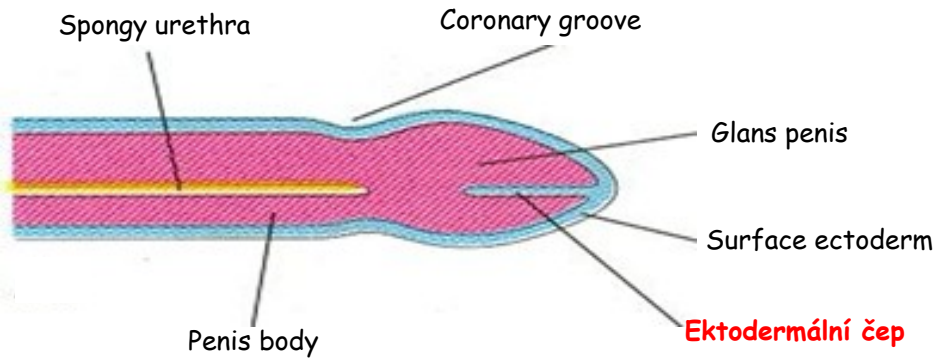
Genital folds form the lateral walls of the urethral groove

Genital folds form the spongy urethra

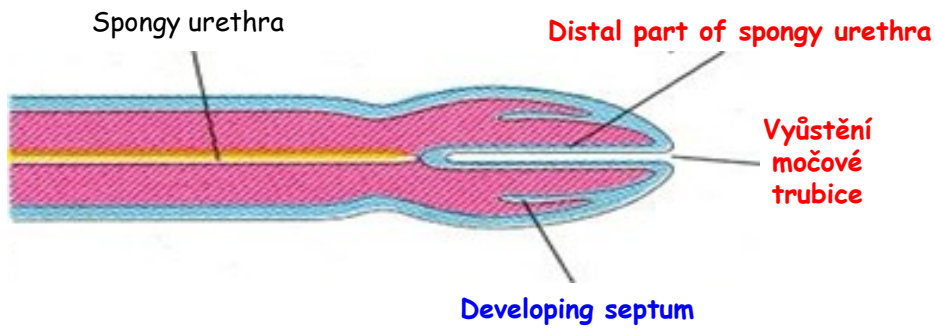
Ventral epithelium of genital folds - urethra proper

Corpora cavernosa develop from mesenchyme

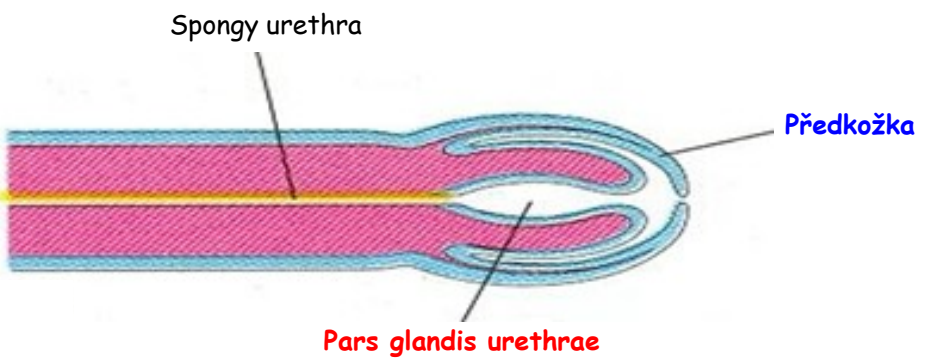
Pohlavní systém - Zevní pohl. orgány - Ústí uretry



- ectodermal ingrowth forms a cellular **ectodermal cord**

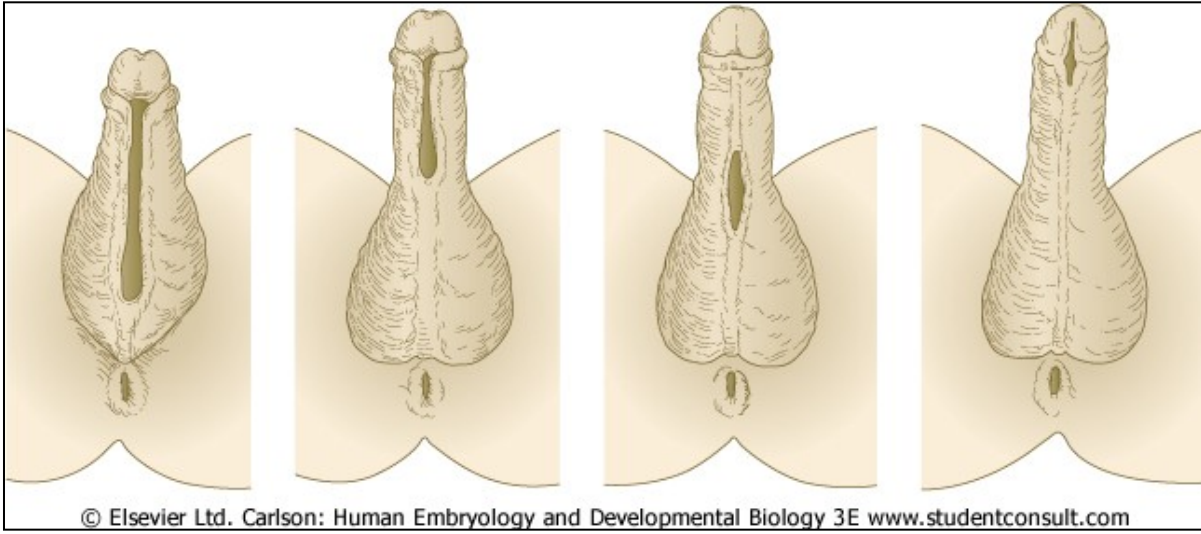


- the **cord** grows towards the root of the penis to meet the spongy urethra
- the **cord** canalizes
- **circular ingrowth** of ectoderm occurs at the periphery of the glans penis (week 12)



- **circular ingrowth** breaks down forming **prepuce** (for some time adherent to the glans penis, hard to retract at birth)

Pohlavní systém - Zevní pohl. orgány - Hypospadiie

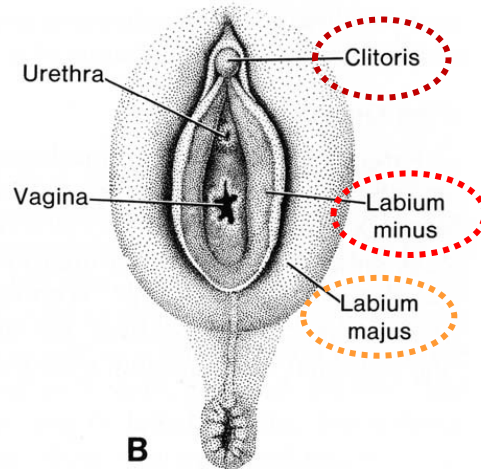
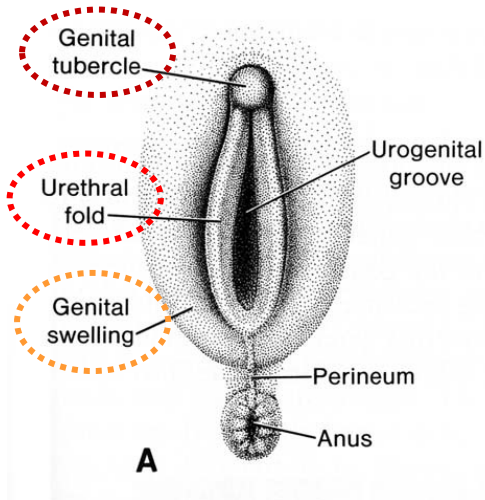


Normal midline raphe



Raphe off center

Pohlavní systém - Zevní pohl. orgány - Ženy



urethra and vagina open into **vestibule** = from urogenital sinus

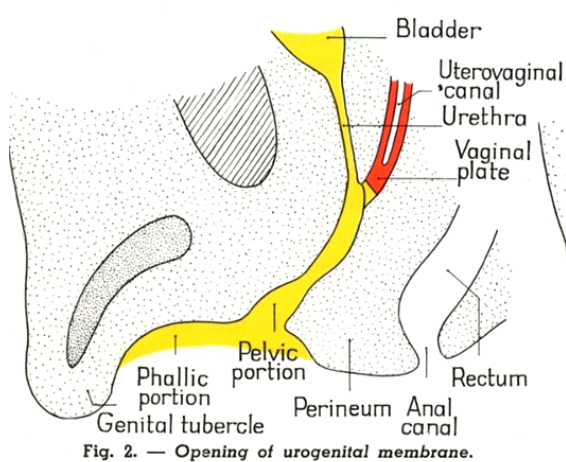


Fig. 2. — Opening of urogenital membrane.

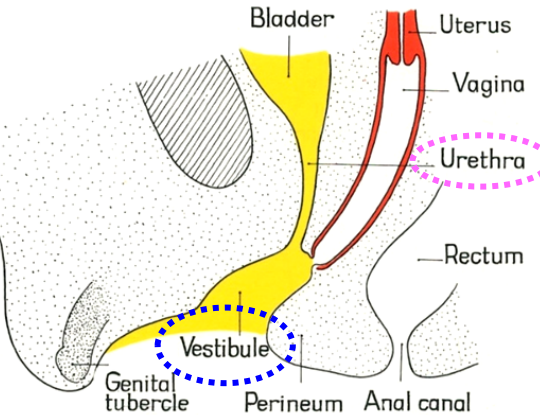


Fig. 3. — The definitive vestibule.

urethra develops from the more cranial part of urogenital sinus - equivalent to prostatic urethra

Thank you for your attention !

Questions and comments at:
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