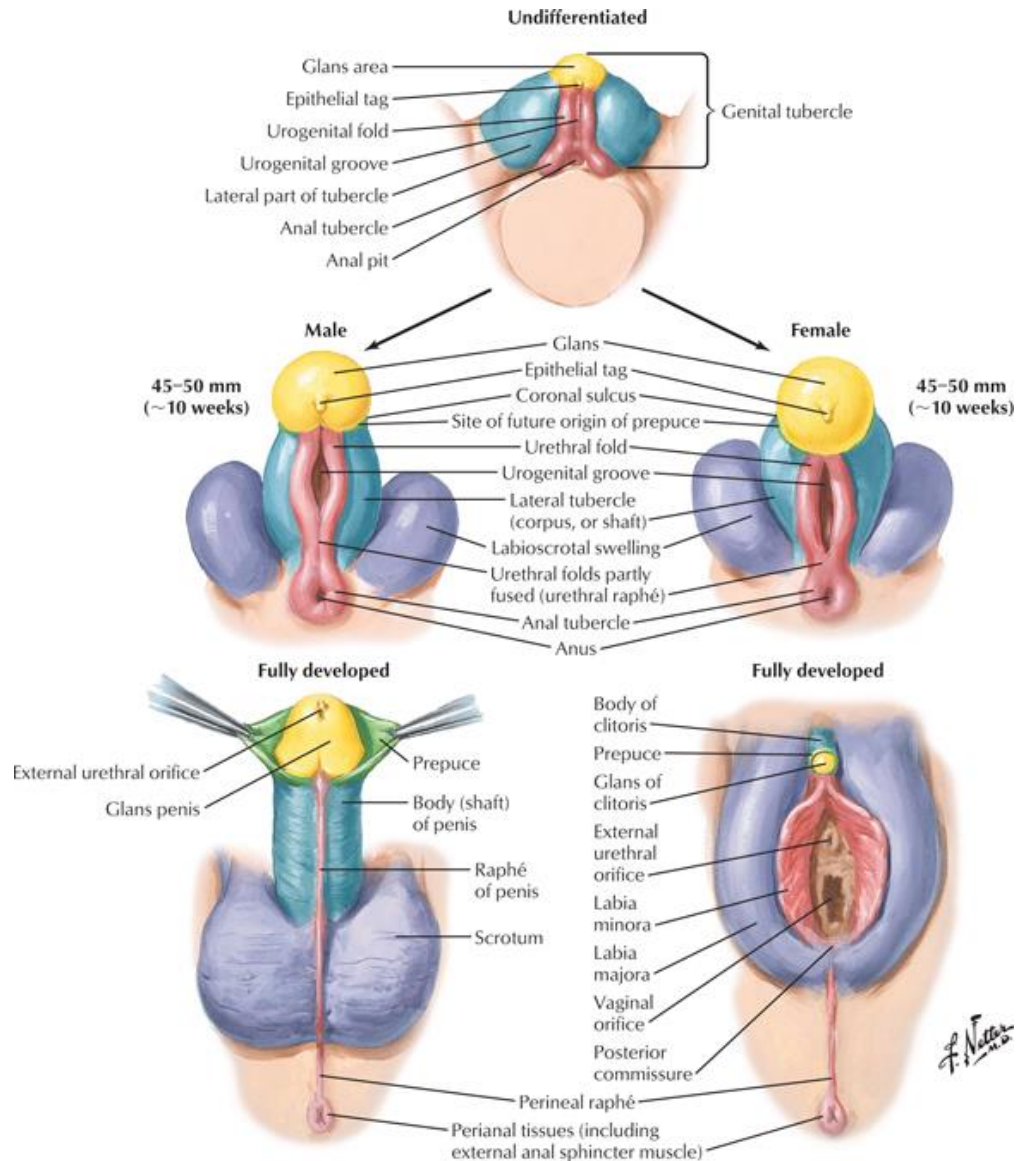


DEVELOPMENT OF UROGENITAL SYSTEM

ANATOMY, HISTOLOGY, EMBRYOLOGY
27. 3. 2024

MUDr. Anna Malečková, Ph.D.
anna.maleckova@lfp.cuni.cz



Today's topics

Development of urinary system

Urogenital ridge

Pronephros

Mesonephros

Metanephros

Cloaca, ureters, urinary bladder

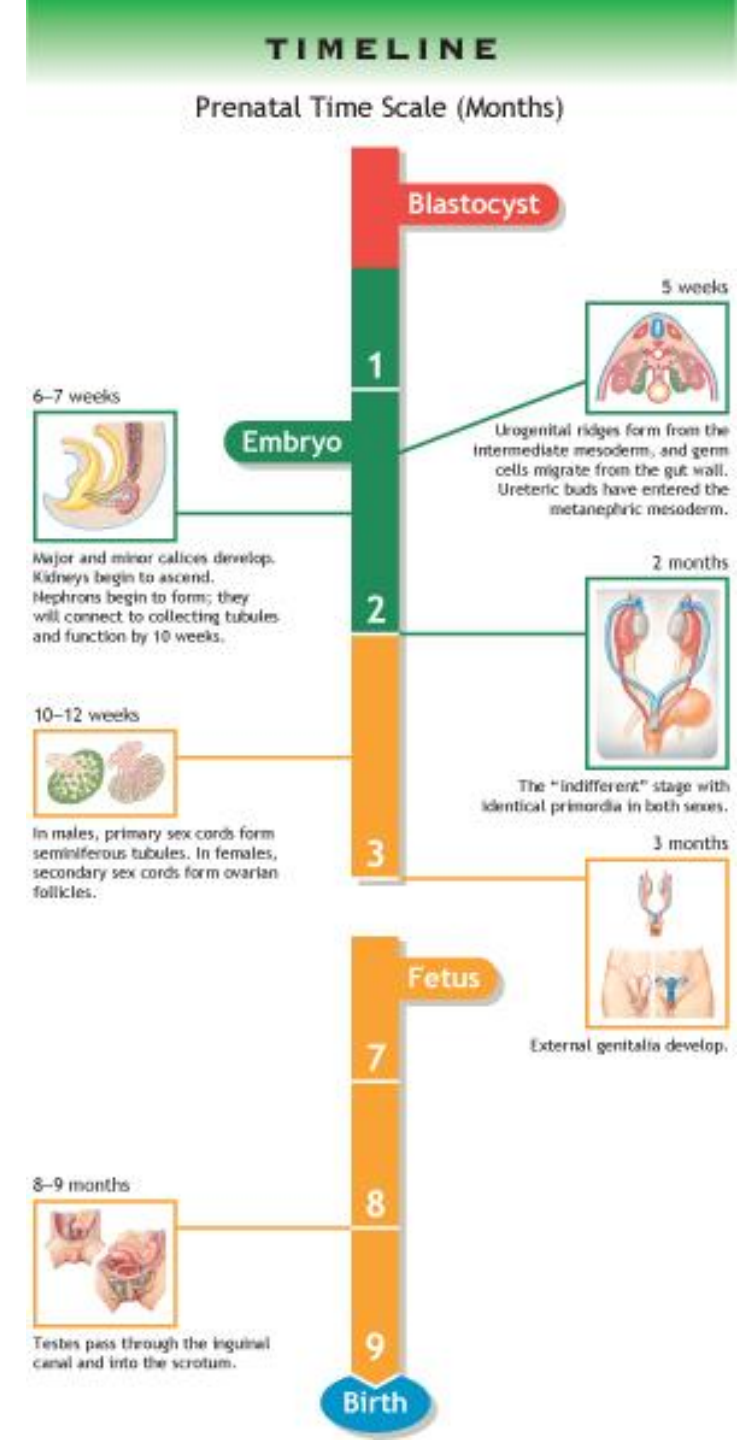
Development of genital system

Indifferent stage of gonads and genital ducts

Testis, epididymis, vas deferens

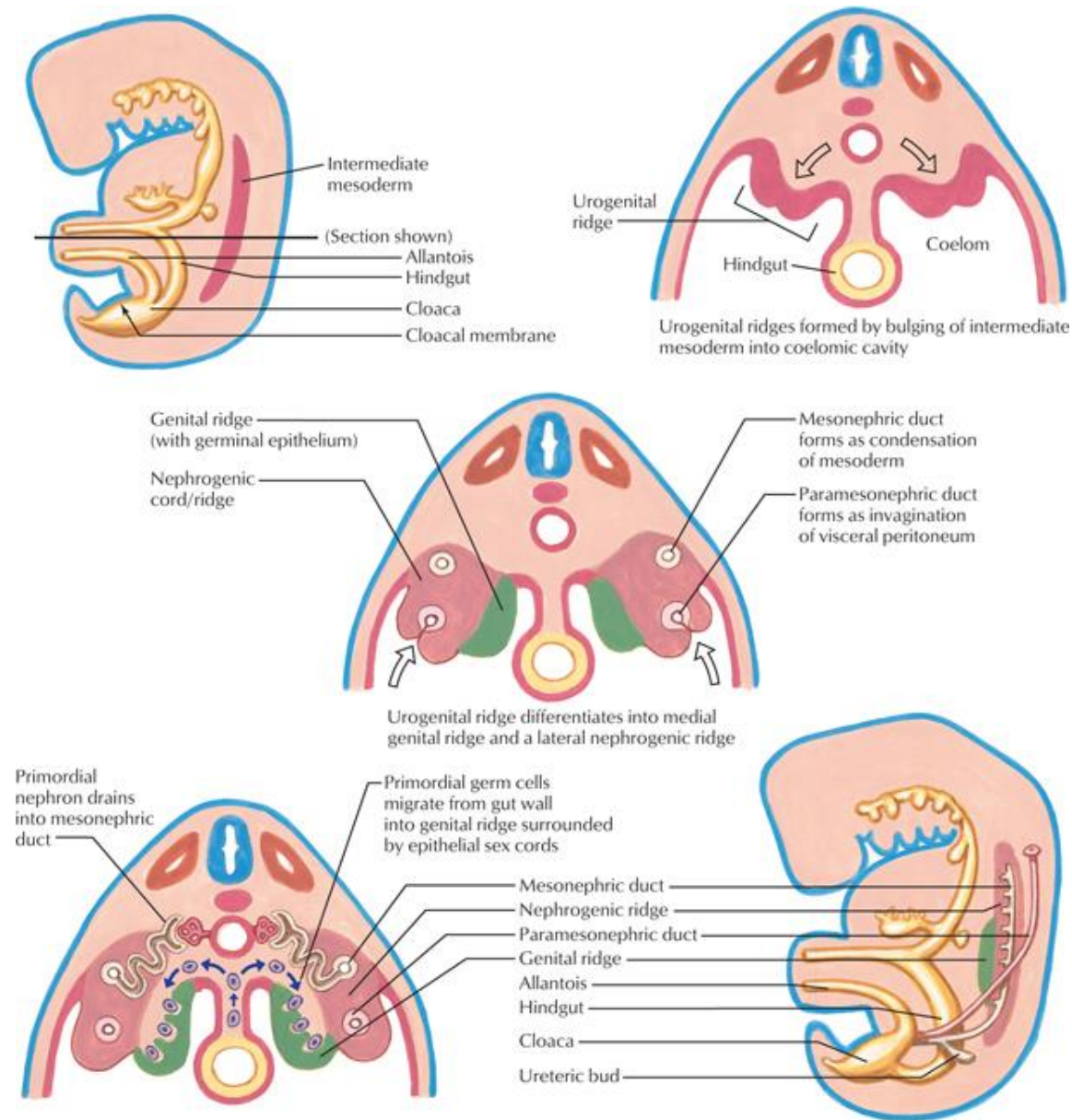
Ovary, uterine tubes, uterus, vagina

External genitalia

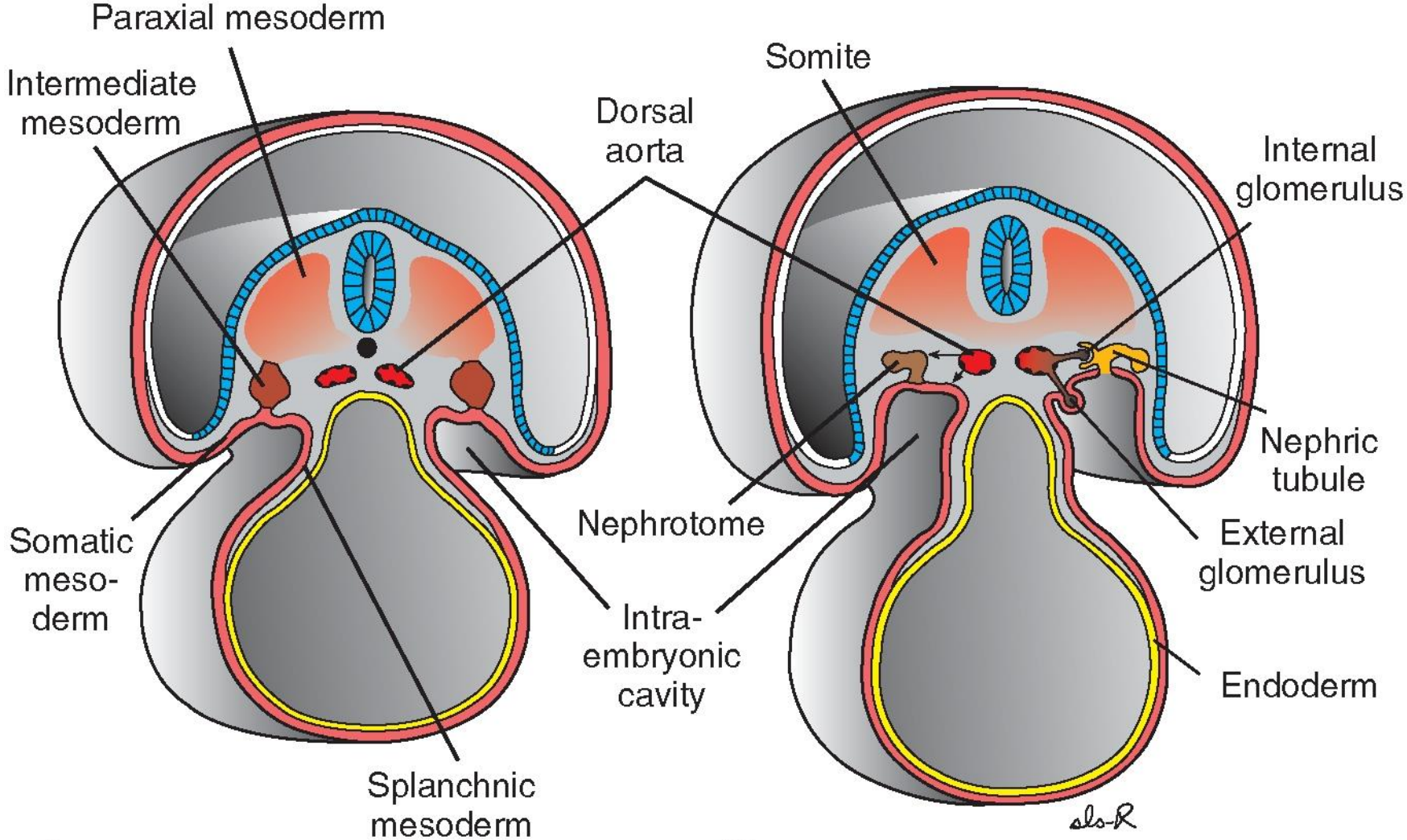


Main principles

- Both systems develop from intermediate mesoderm
- Cloaca represents common repository
- Early structures of one system are transformed into structures of the other system
- Presence of structures typical for lower vertebrates
- Epithelial-mesenchymal interactions
- Indifferent organs change based on the sex



Intermediate mesoderm, urogenital ridge



Intermediate mesoderm, urogenital ridge



Three successive „kidneys“

- **PRONEPHROS: 3. – 4. week**

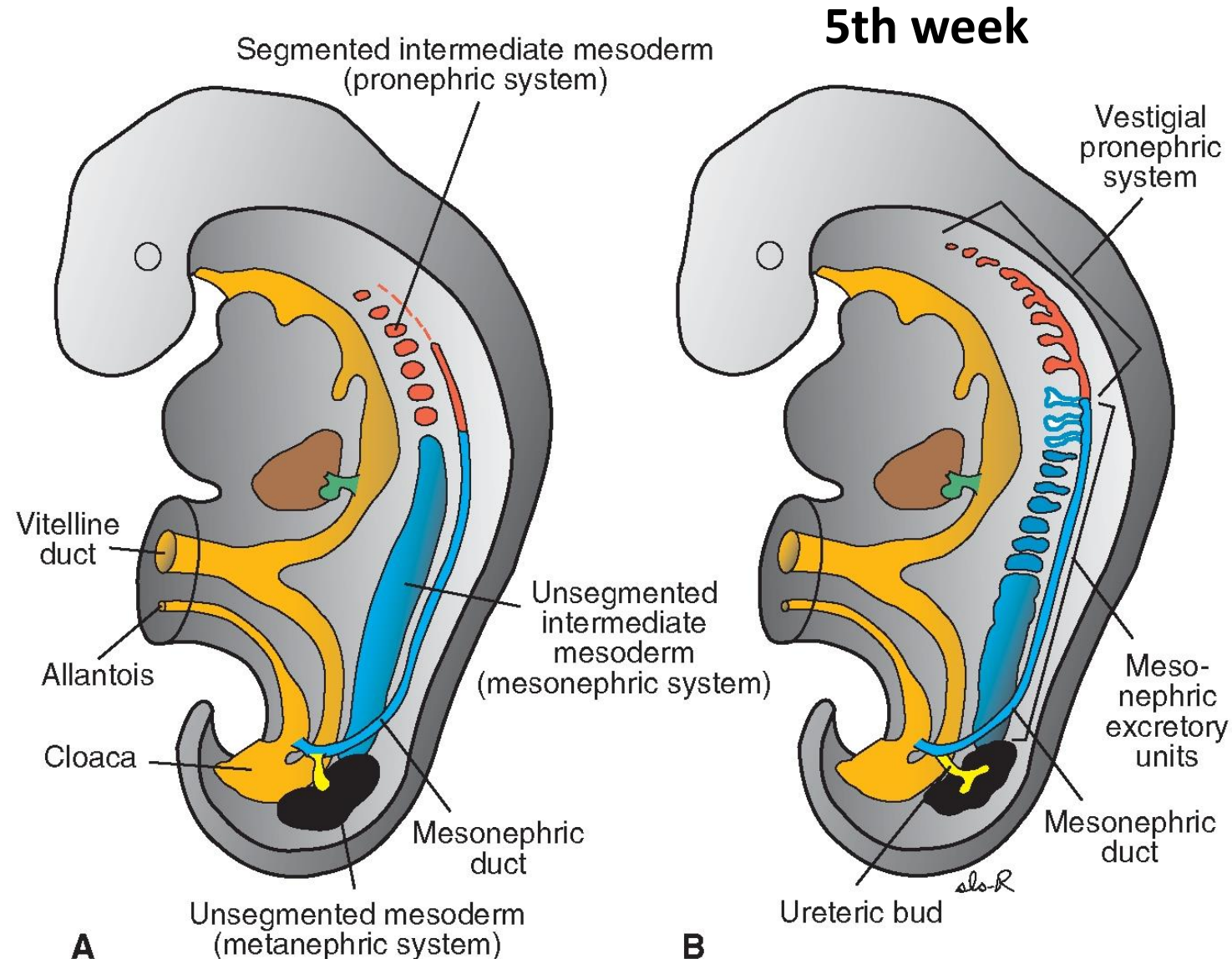
- Temporary organ in cervical region (C2,3 – Th1)
- Quickly diminishes

- **MESONEPHROS: 4. – 6. week**

- Thoracic – lumbar region (Th2 – L3)
- Partially diminishes – different development in male and female

- **METANEPHROS: from 5. week**

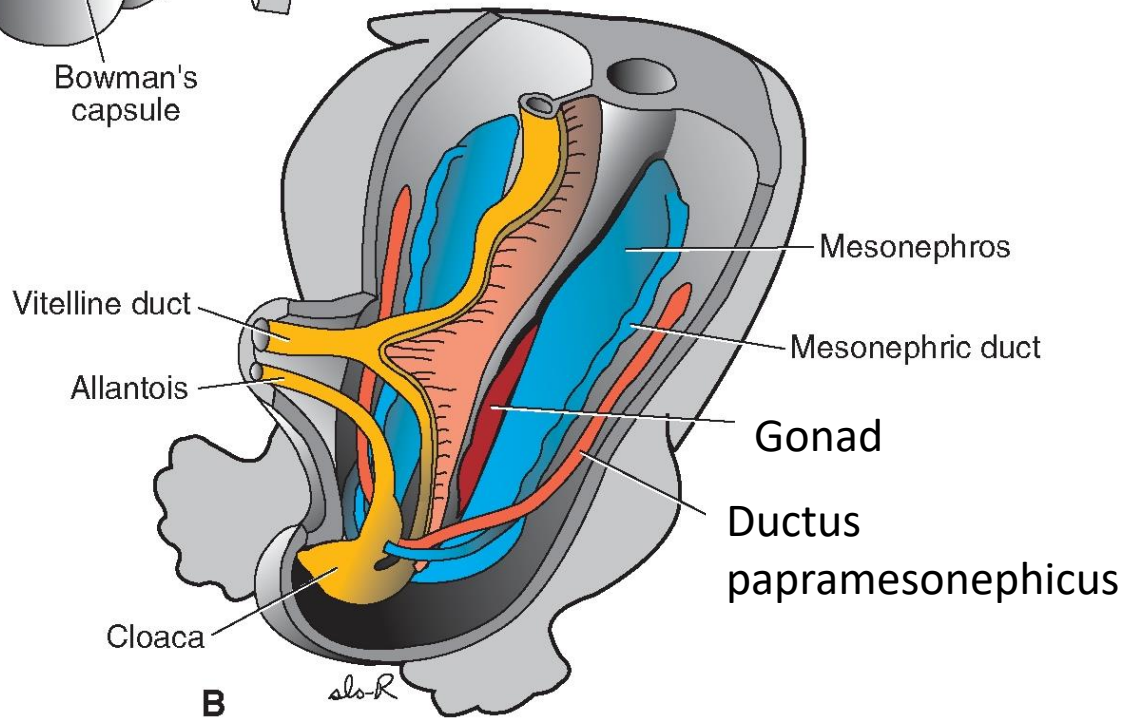
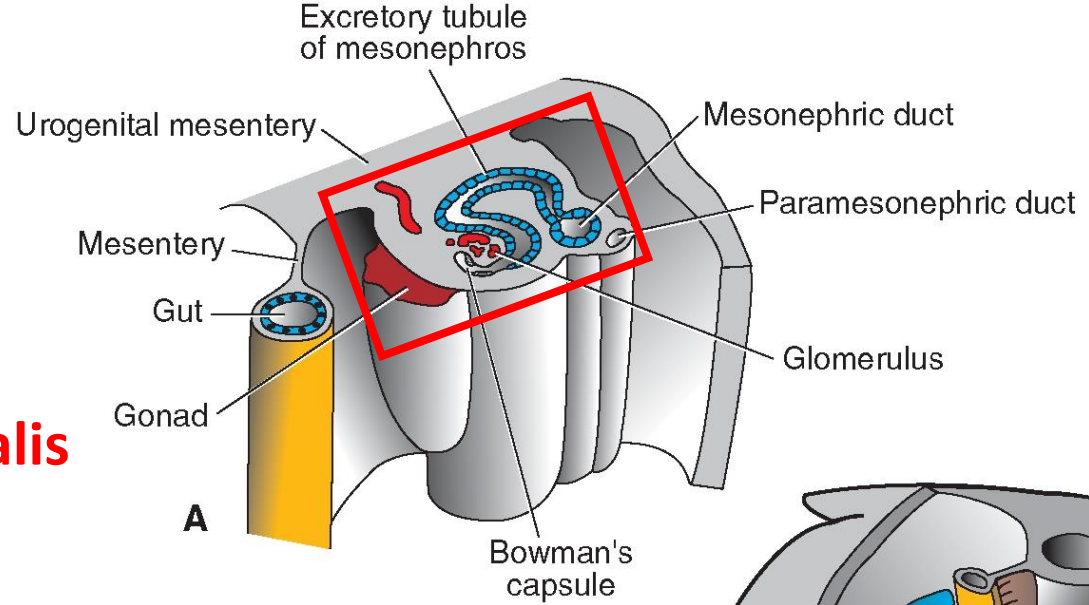
- Lumbar region (L4,5)
- Permanent kidney



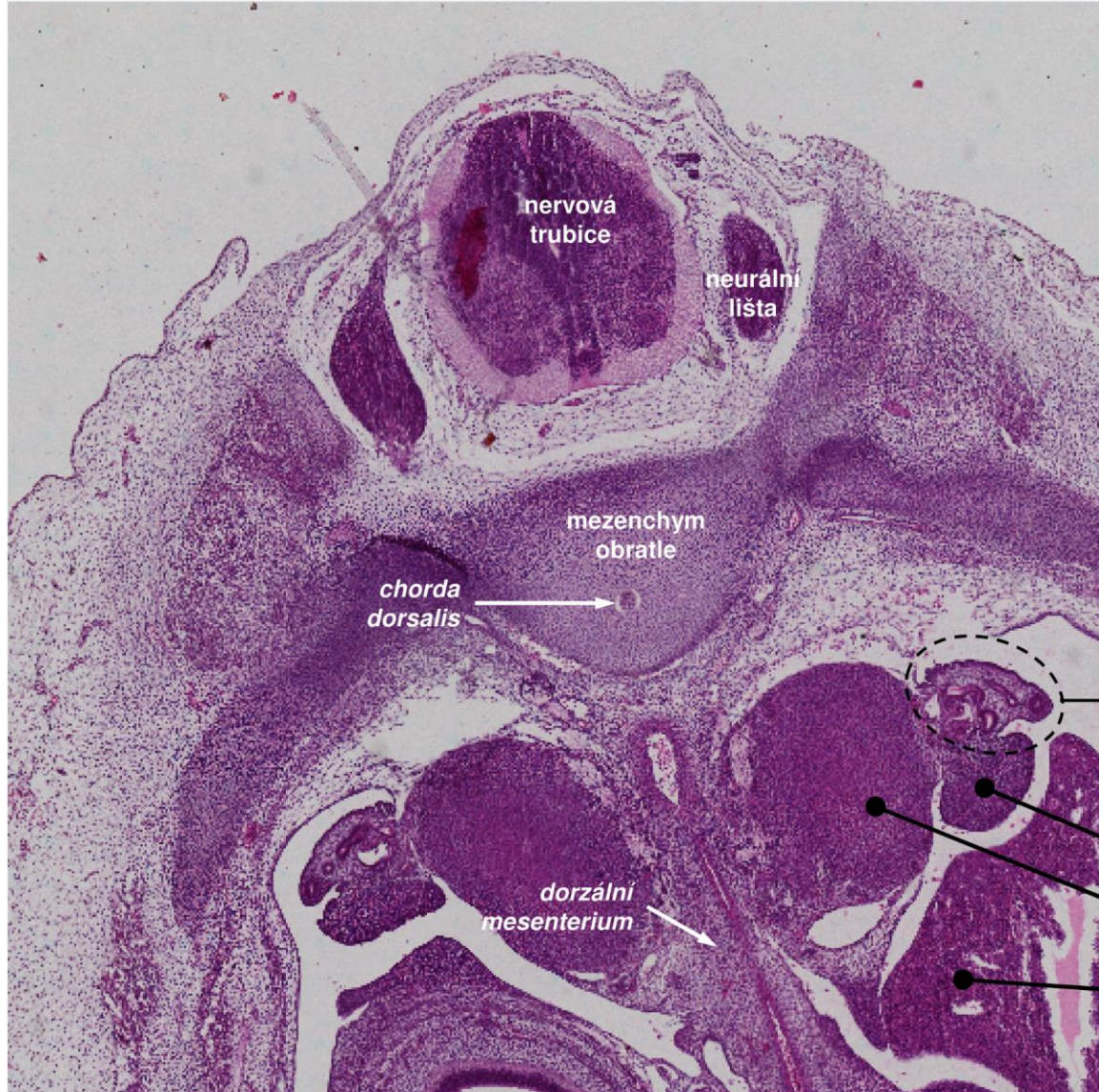
Intermediate mesoderm, urogenital ridge

5th week

Plica urogenitalis



Intermediate mesoderm, urogenital ridge

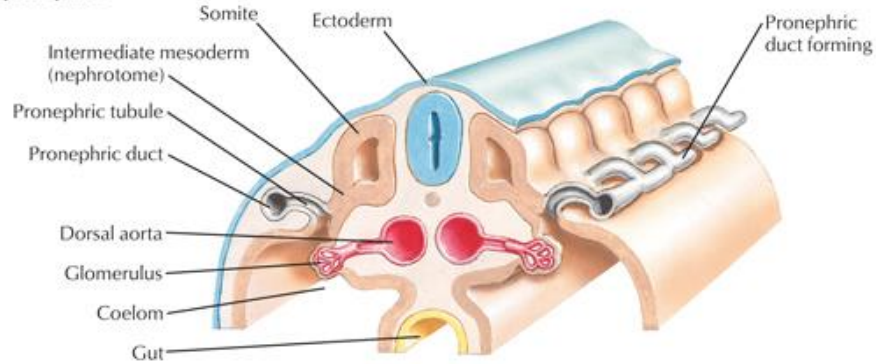


- mesonephros
mesonefrický (Wolffův) vývod
paramesonefrický (Müllerův) v.
- gonáda v indiferentním stádiu
- kůra nadledviny
- játra

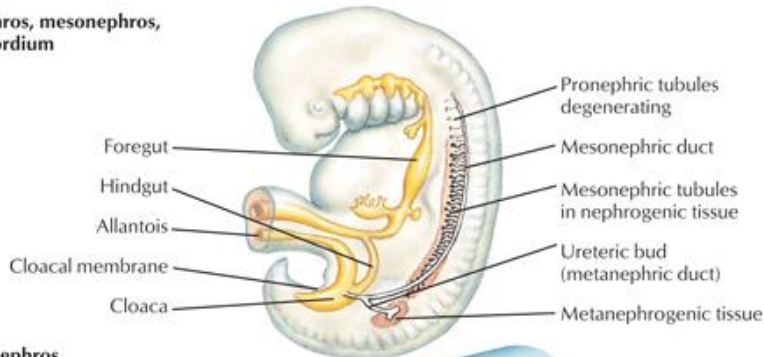
Gonadální lišta (Carnegie 17, ~42. den, 12 mm, transverzální řez) – H&E

Pronephros, mesonephros

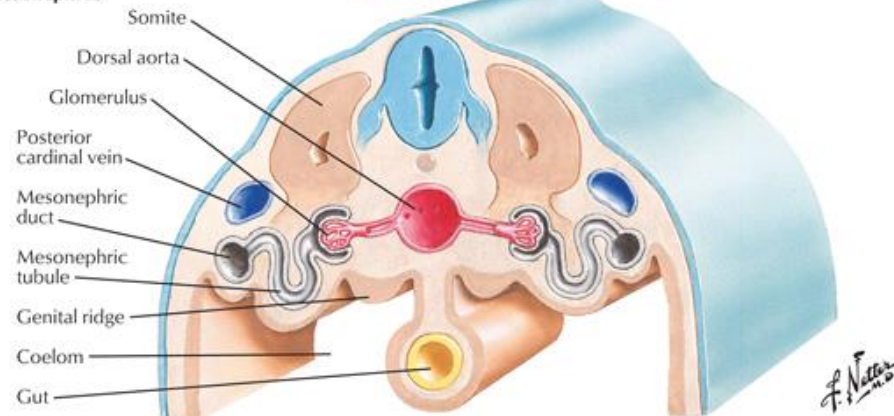
Section through pronephros



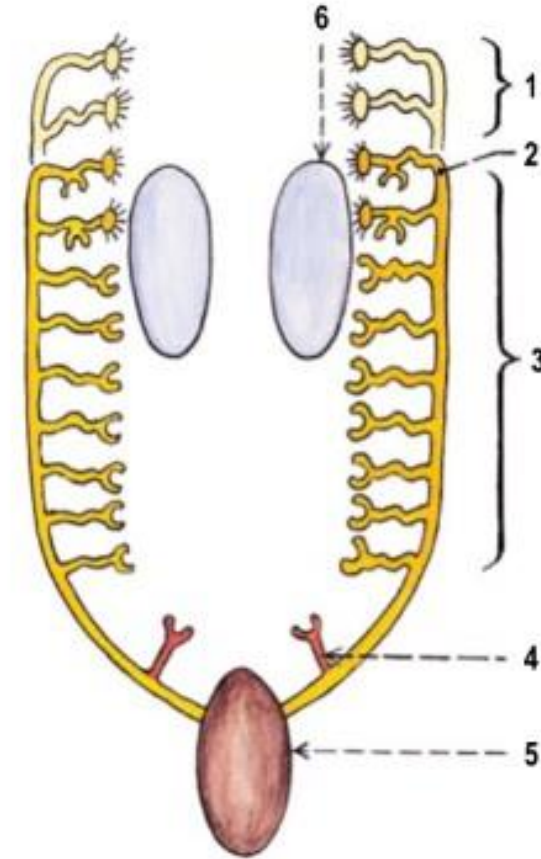
Topography of pronephros, mesonephros, and metanephric primordium



Section through mesonephros



Cochard: Netter's Atlas of Human Embryology
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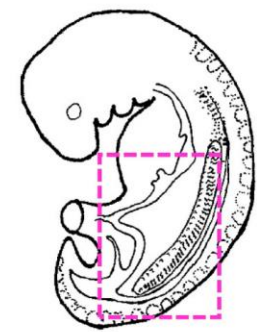
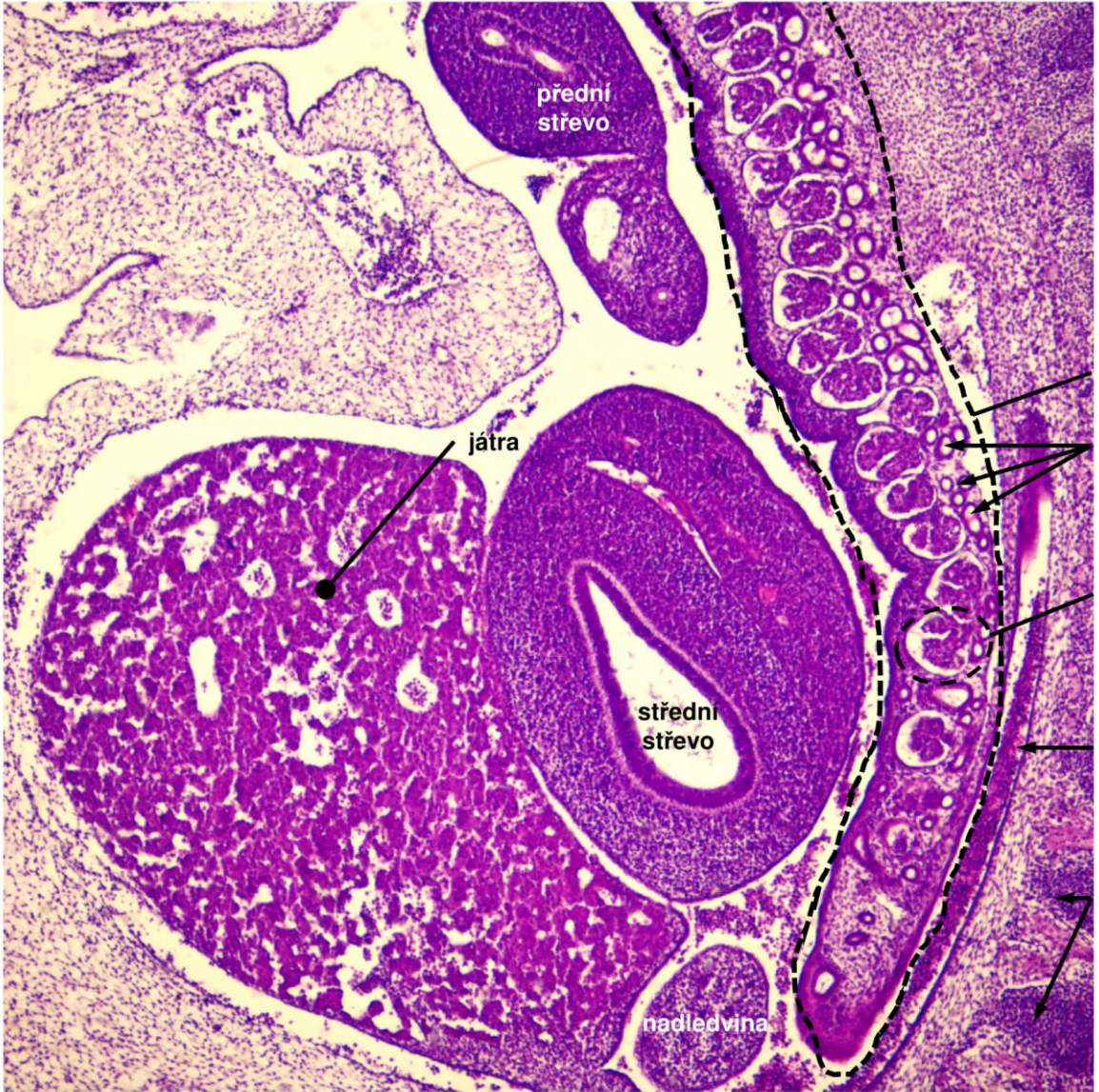


Obr. 208. SCHEMA RANÝCH VÝVOJOVÝCH FÁZÍ MOČOVÉHO ÚSTROJÍ

- 1 zanikající kanálky pronephros
- 2 ductus Wolffii
- 3 kanálky mesonephros
- 4 ureterový pupen
- 5 kloaka
- 6 základ gonády

Čihák R, Anatomie 2, Druhé, upravené a doplněné vydání, Grada, 2002

Mesonephros



- mesonephros
- odvodné kanálky
- corpusculum renale (tj. glomerulus a Bowmannovo pouzdro)
- abdominální aorta
- tvořící se obratle

Mesonephros (Carnegie 15, ~35. den, 8 mm, sagitální řez) – H&E

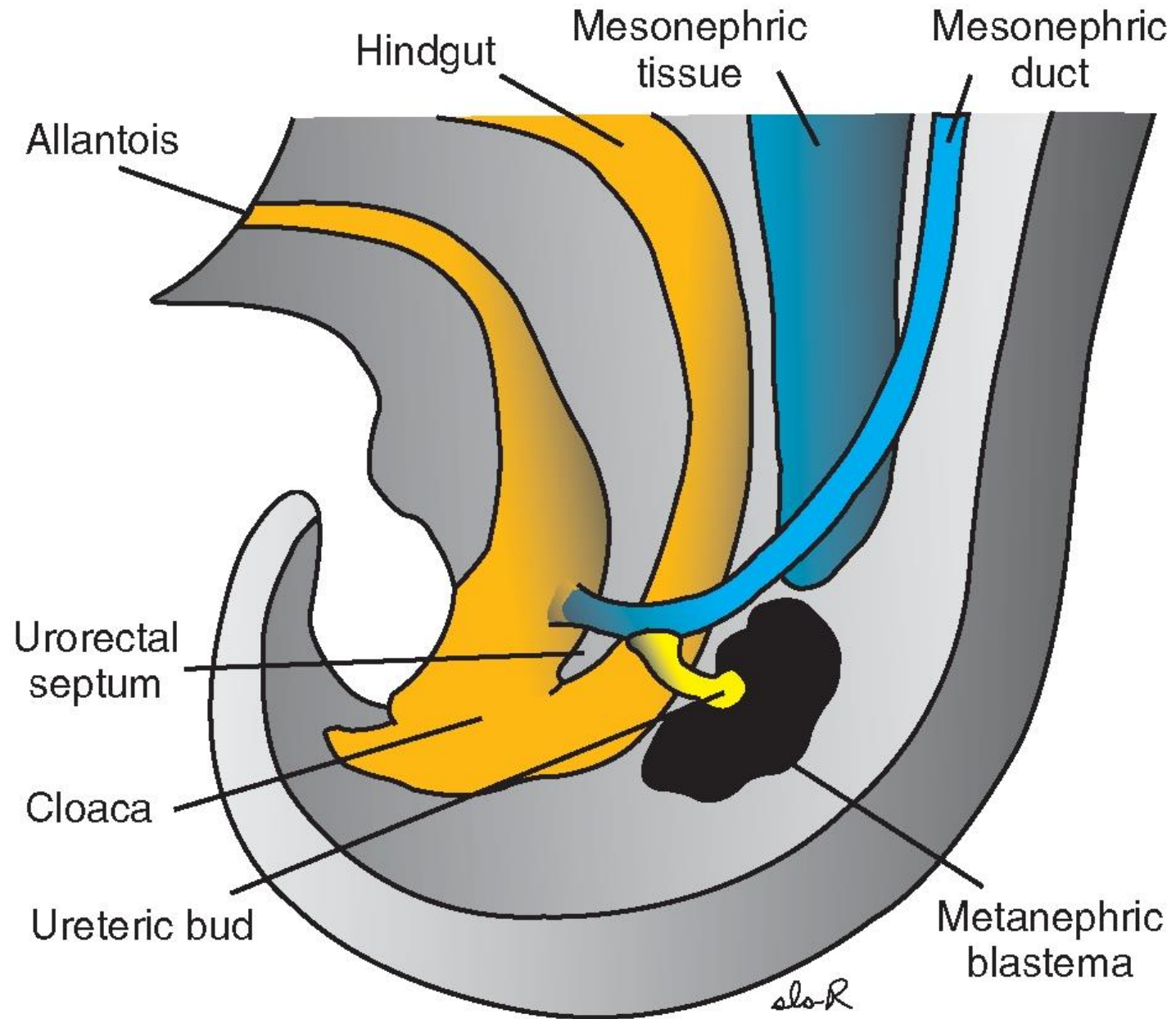
Metanephros

- **URETERIC BUD**

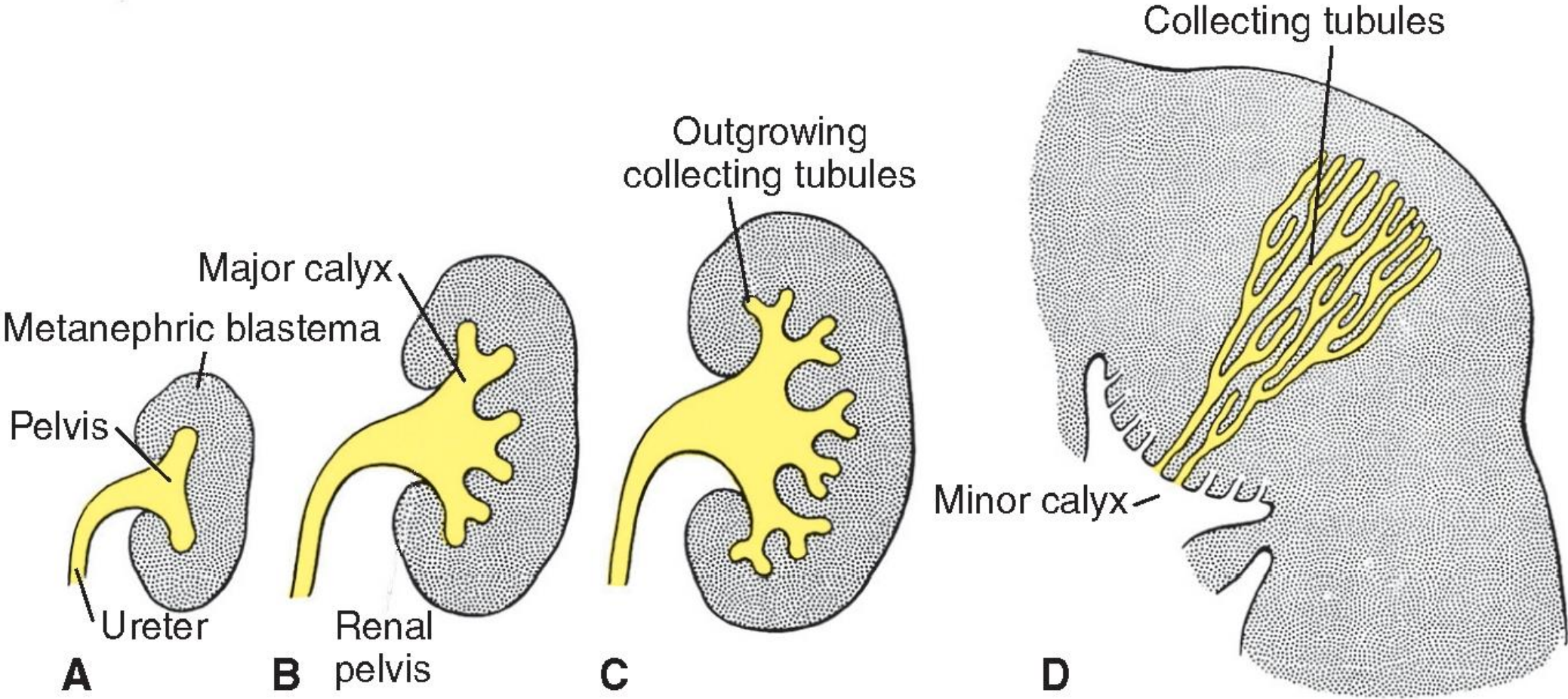
- Ureter
- Renal pelvis
- Major and minor calyces
- Collecting tubules

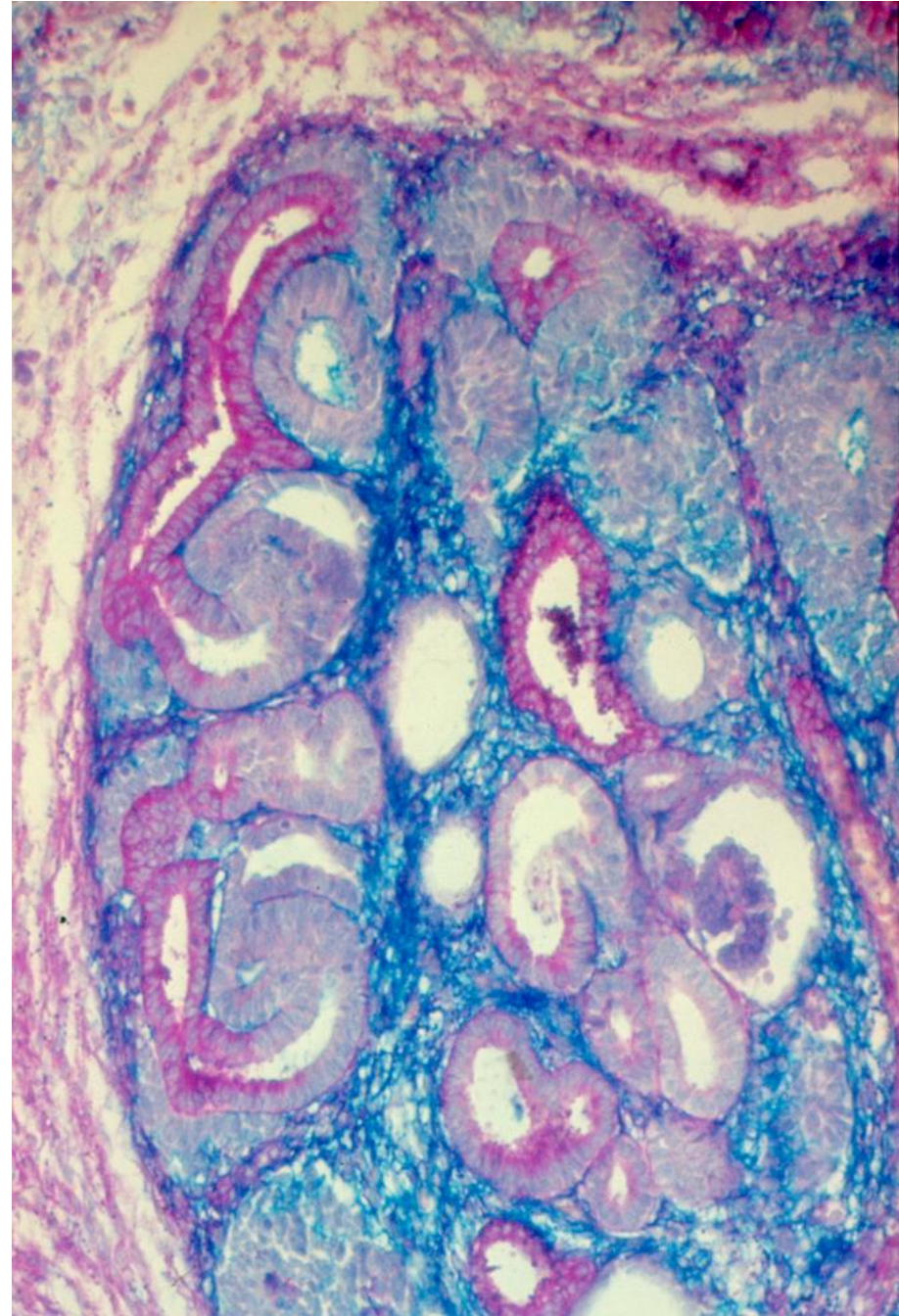
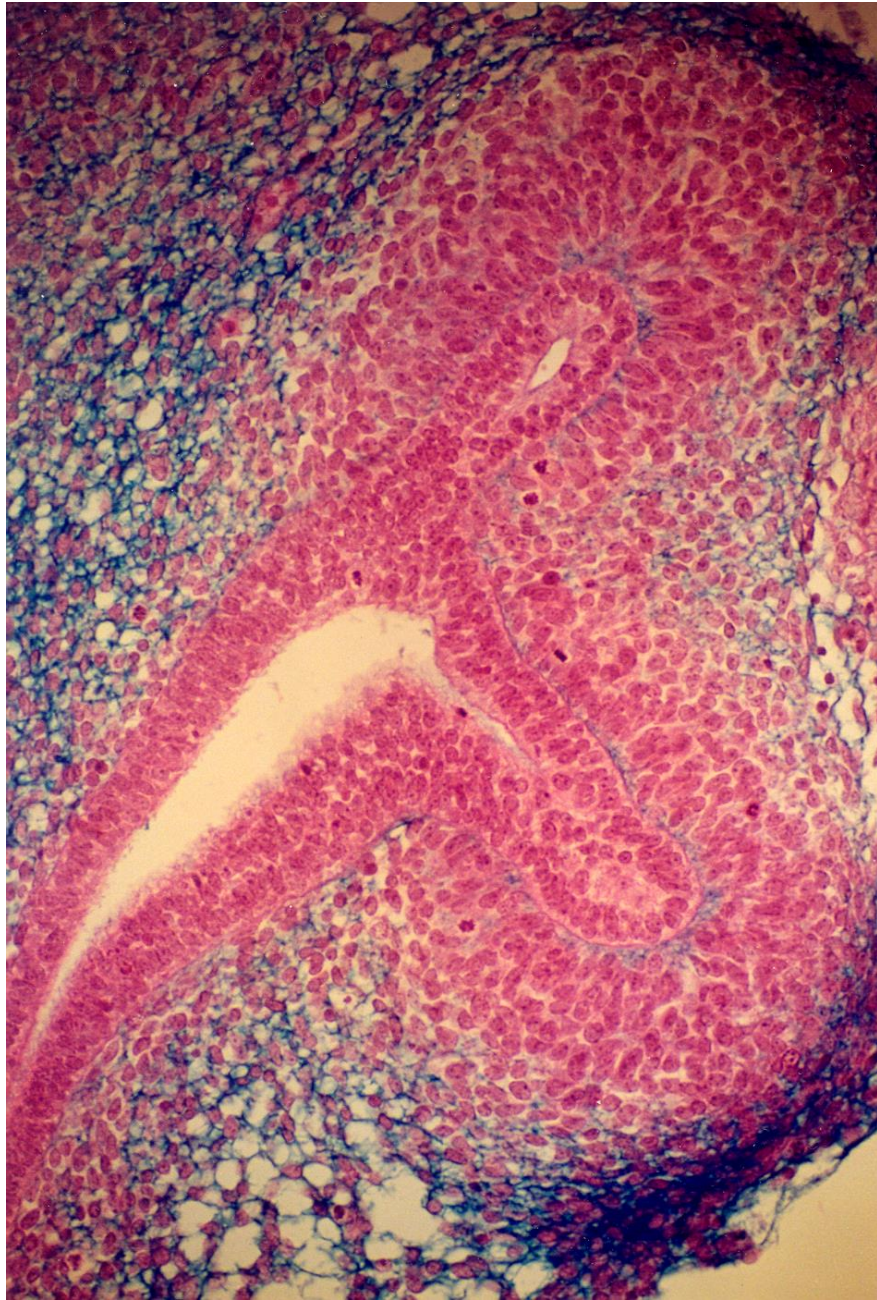
- **METANEPHRIC BLASTEMA**

- Nephron:
 - Bowman's capsule
 - Proximal tubules
 - Loop of Henle
 - Distal tubules

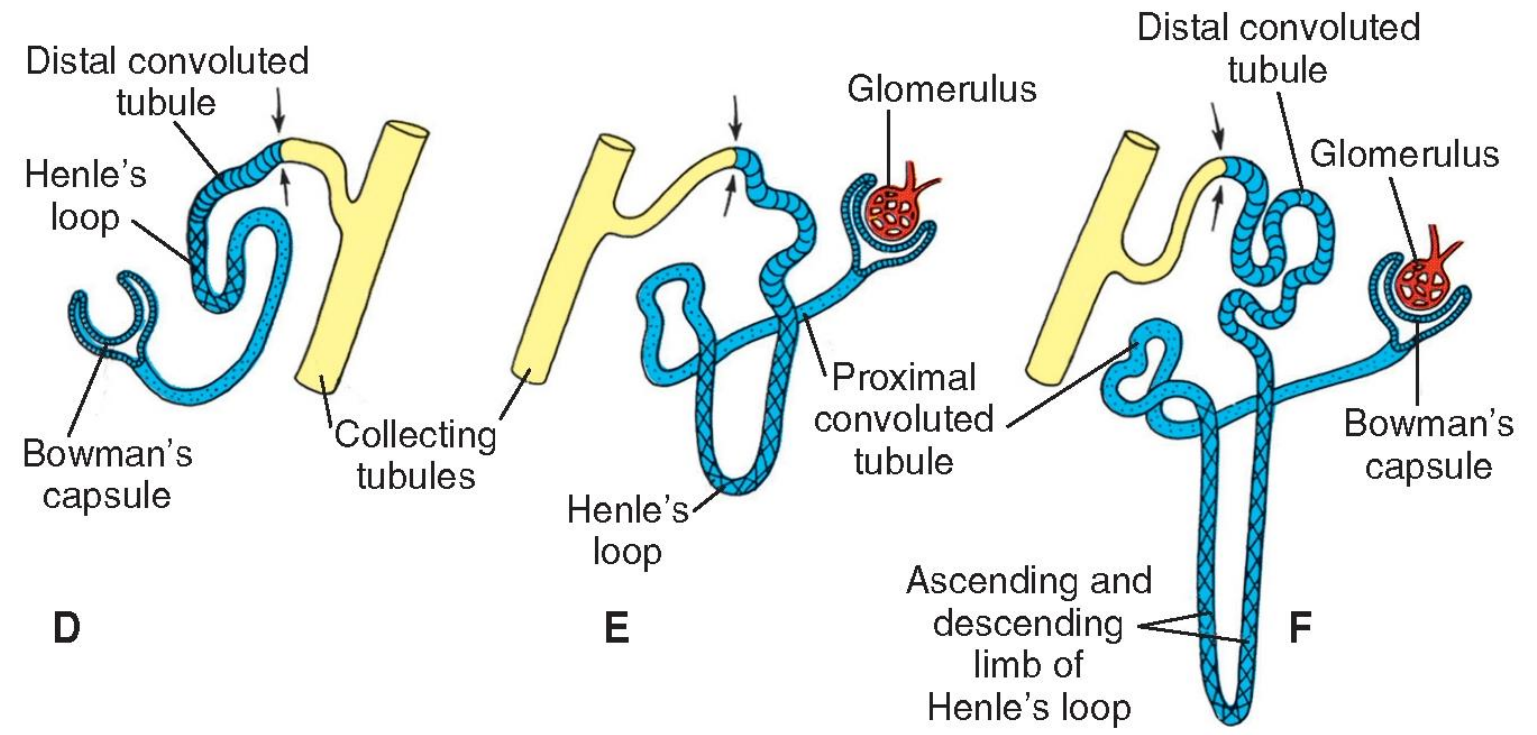
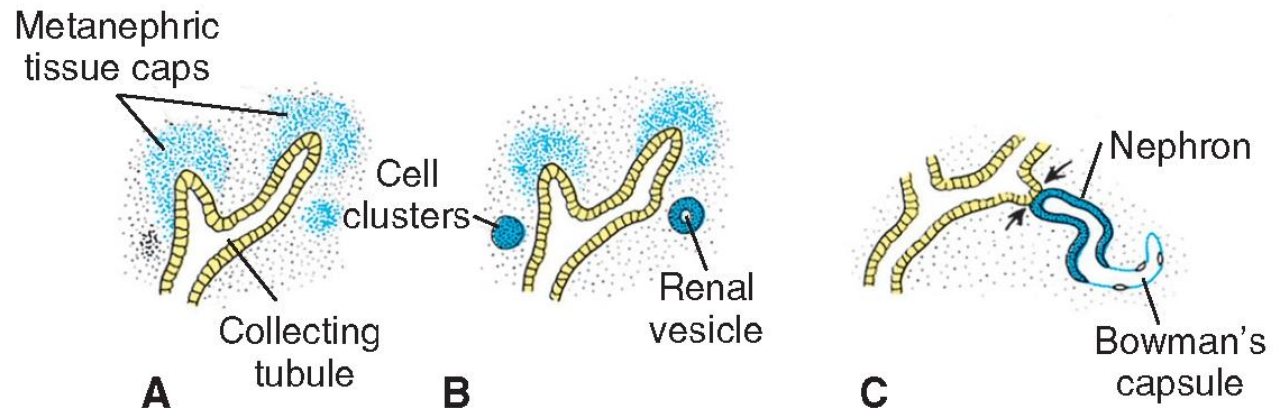


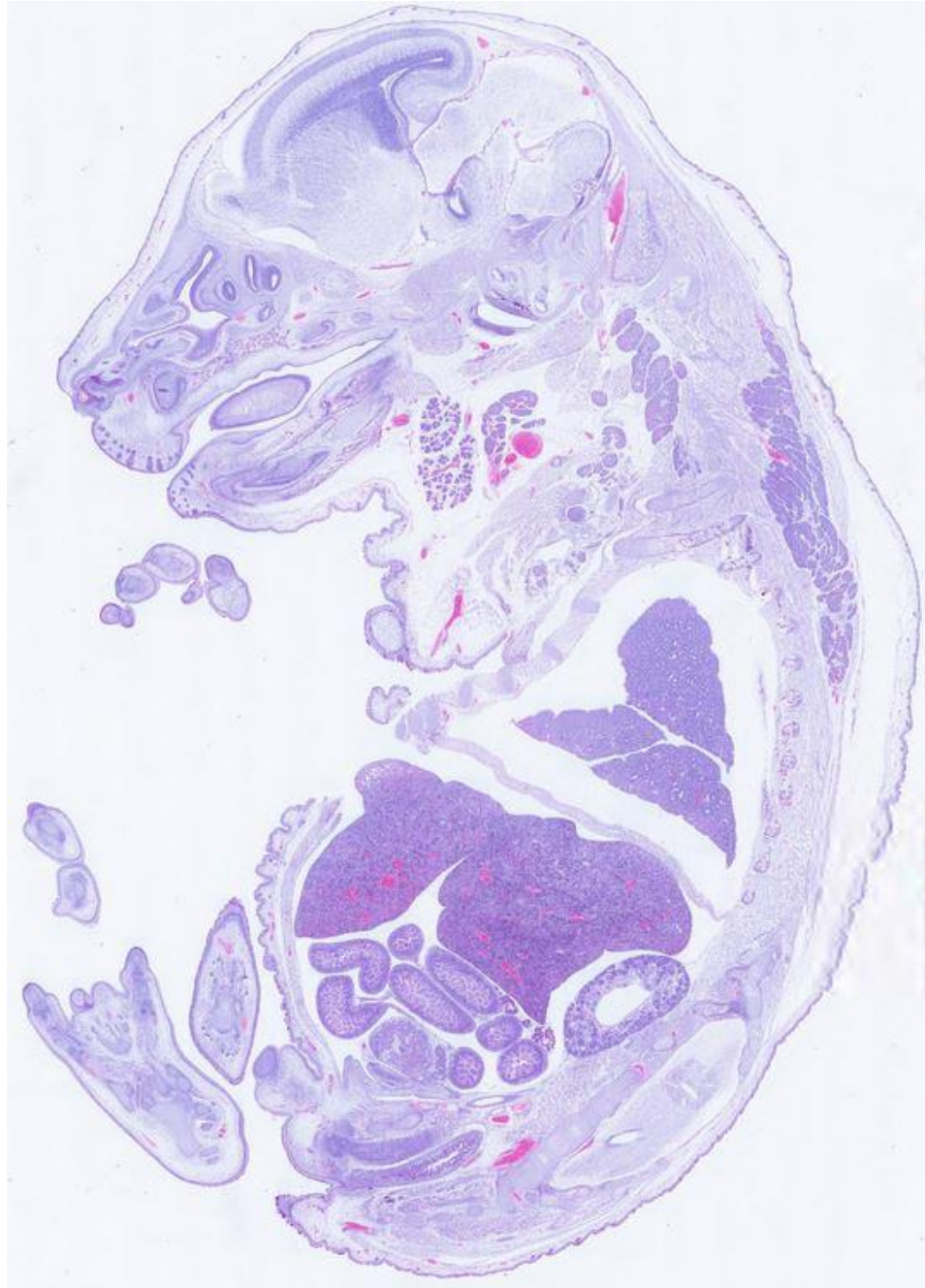
Metanephros – ureteric bud





Metanephros





<https://lfp.smartzoom.com/share/e6a5c68328ce5d6fb00749f59d65d39d8c72a720d44820c467687175ceed4291>

Abdominal wall

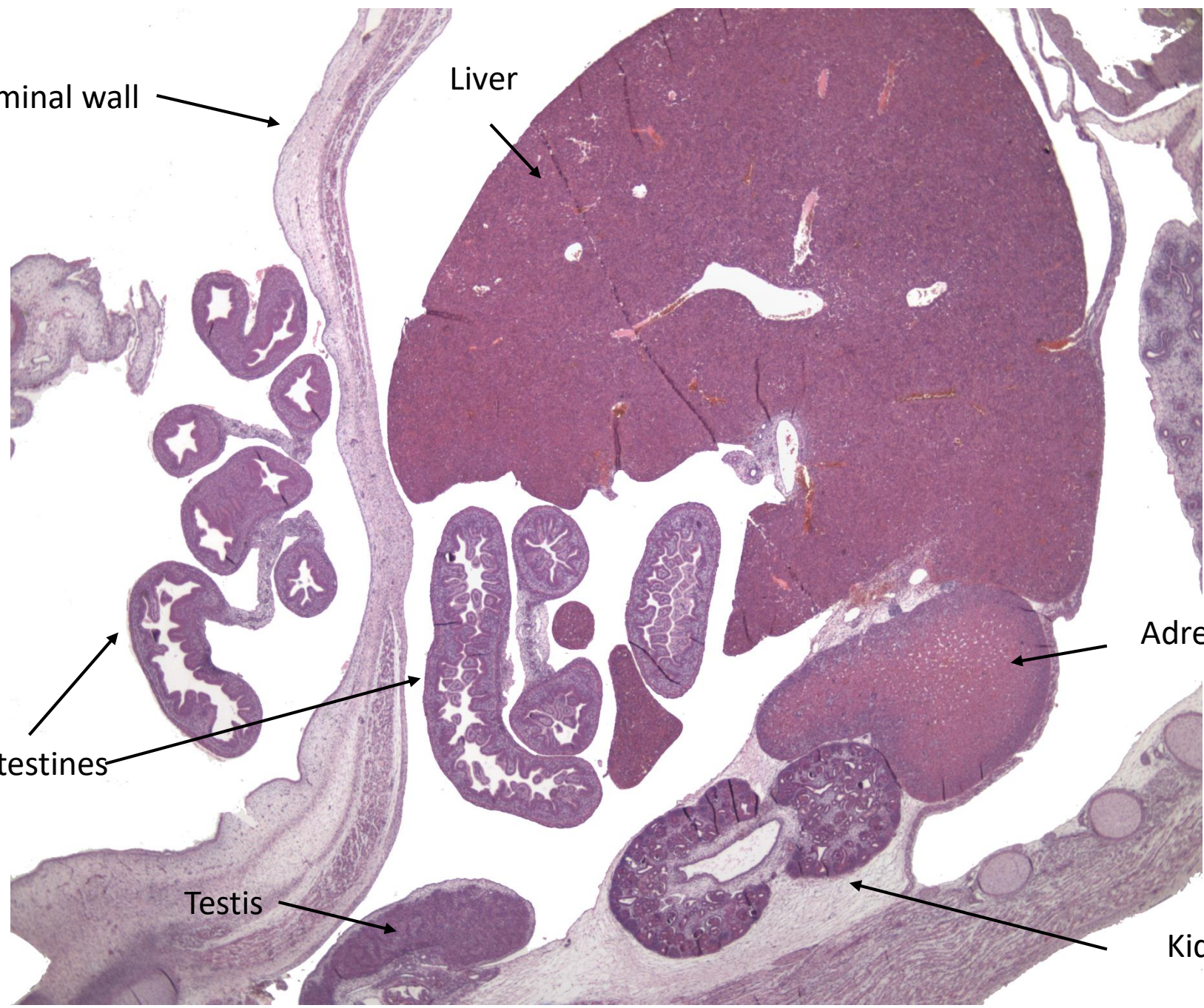
Liver

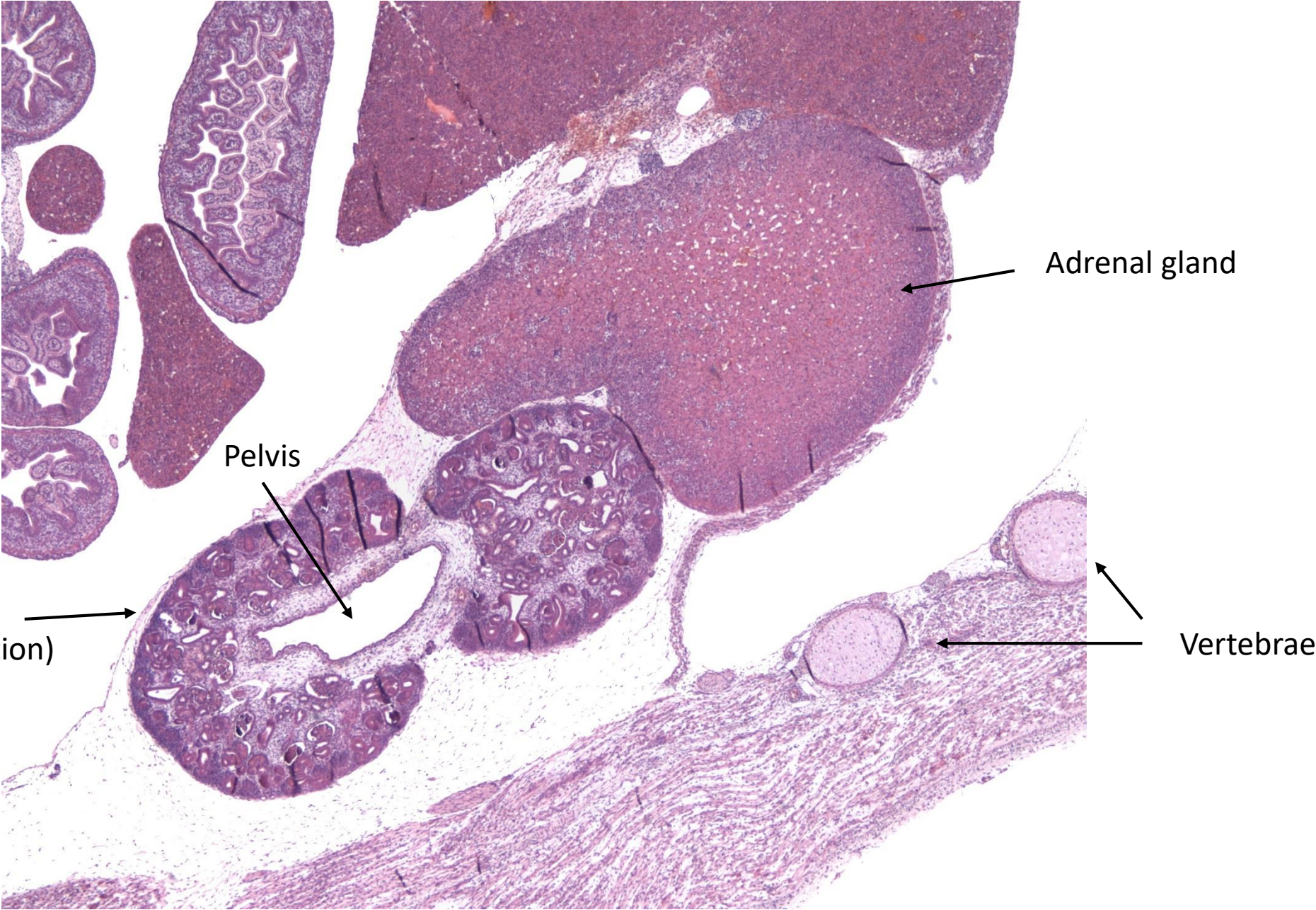
Adrenal gland

Intestines

Testis

Kidney



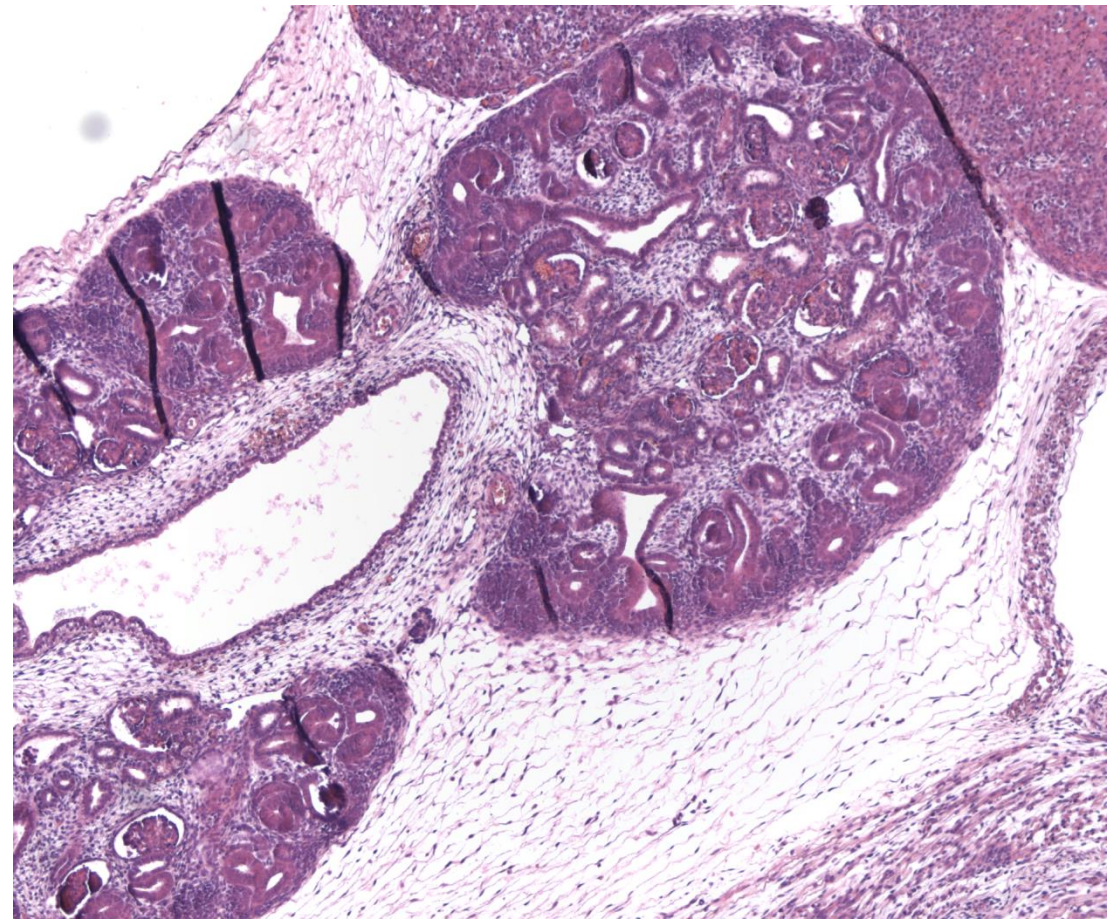
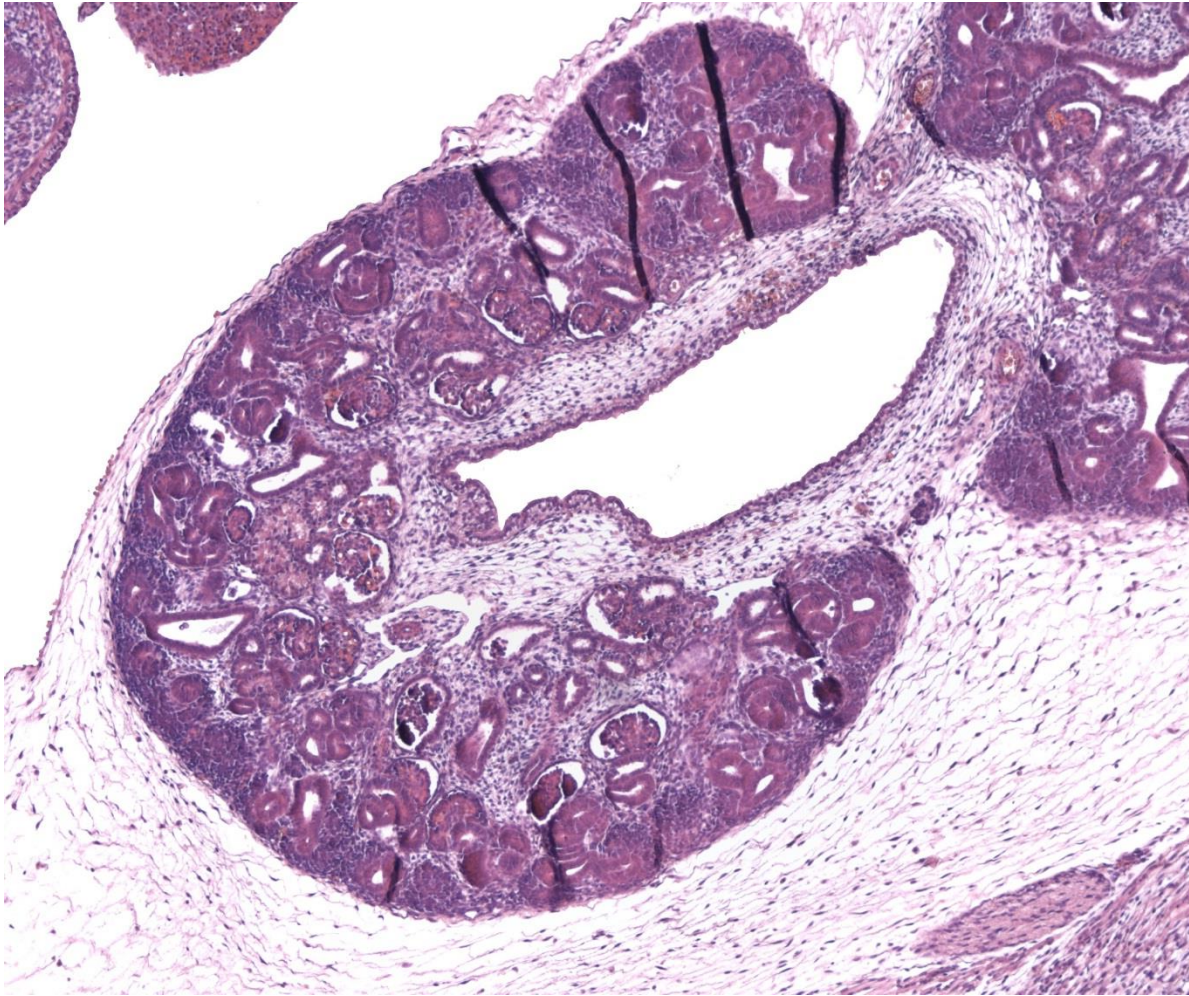


Kidney
(fetal lobulation)

Pelvis

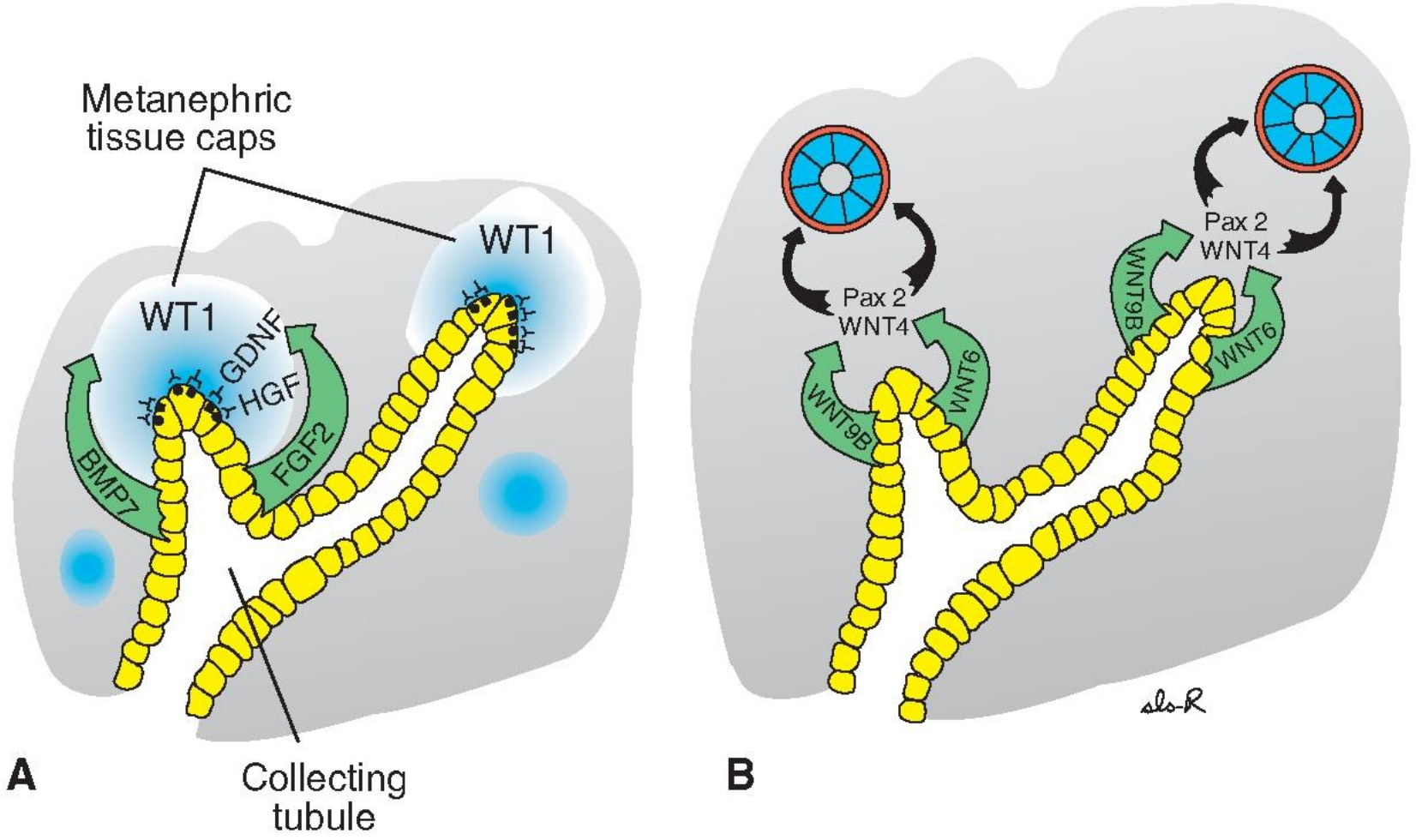
Adrenal gland

Vertebrae



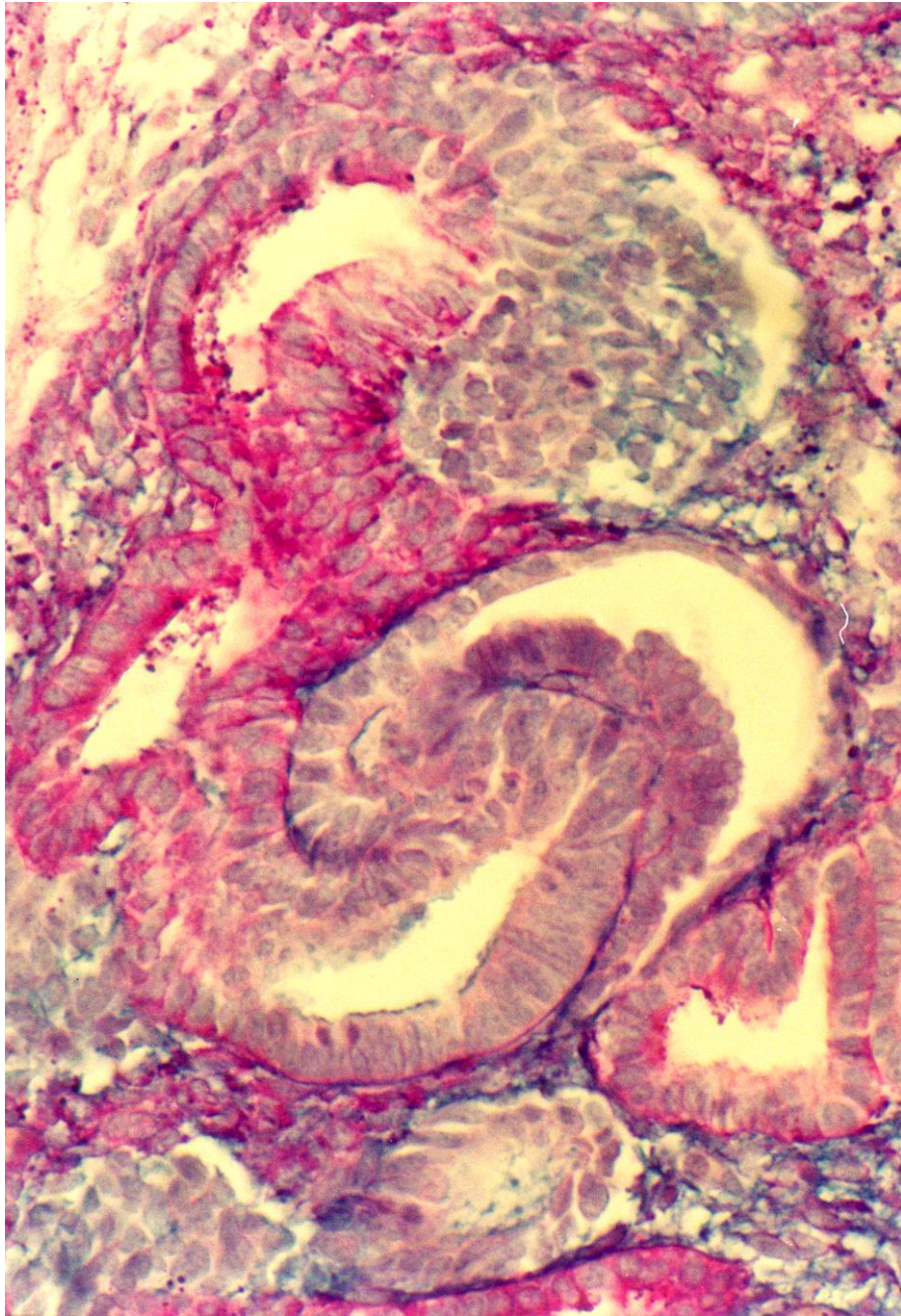
Kidney
(fetal lobulation)

Metanephros – molecular regulation



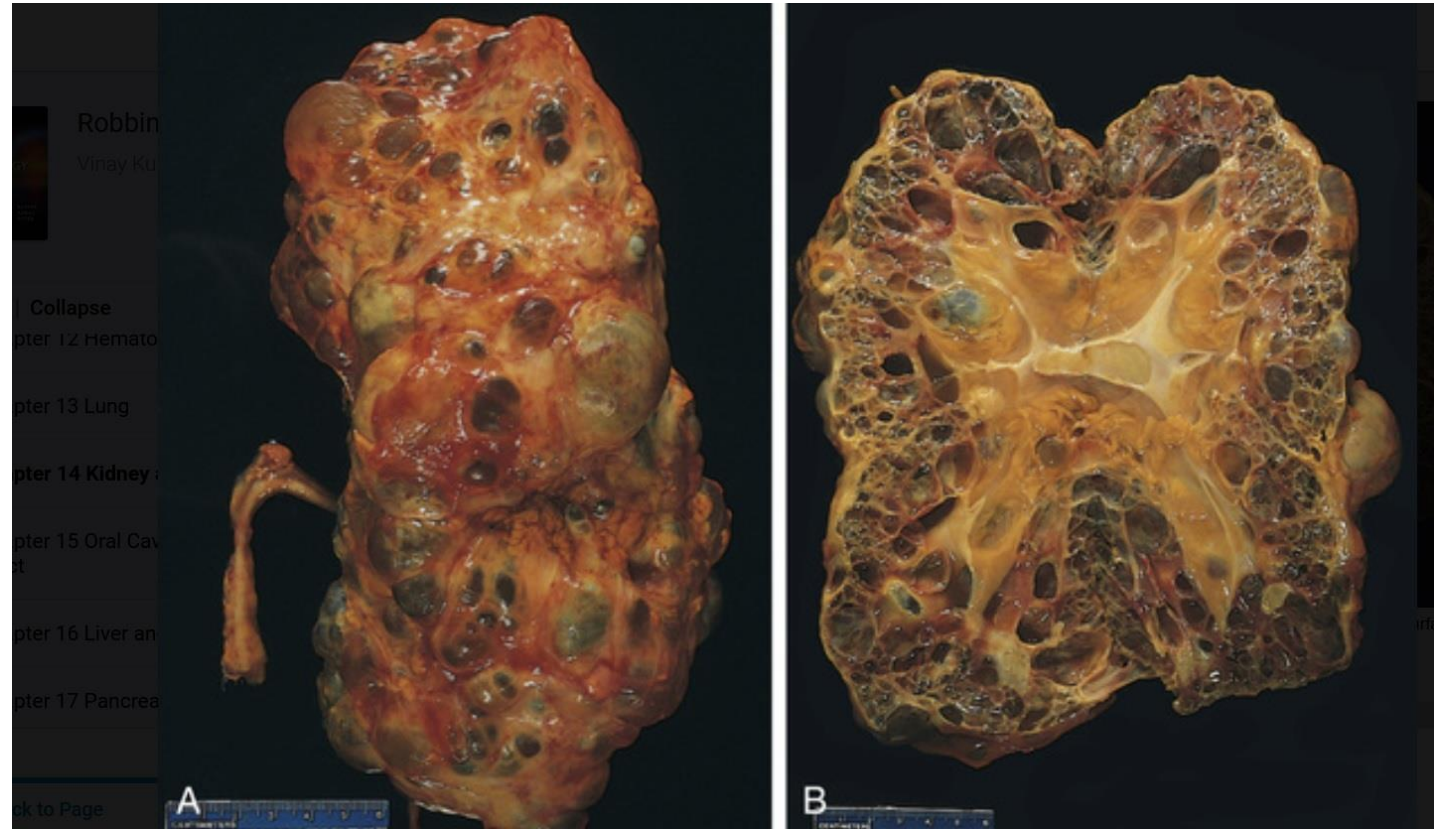
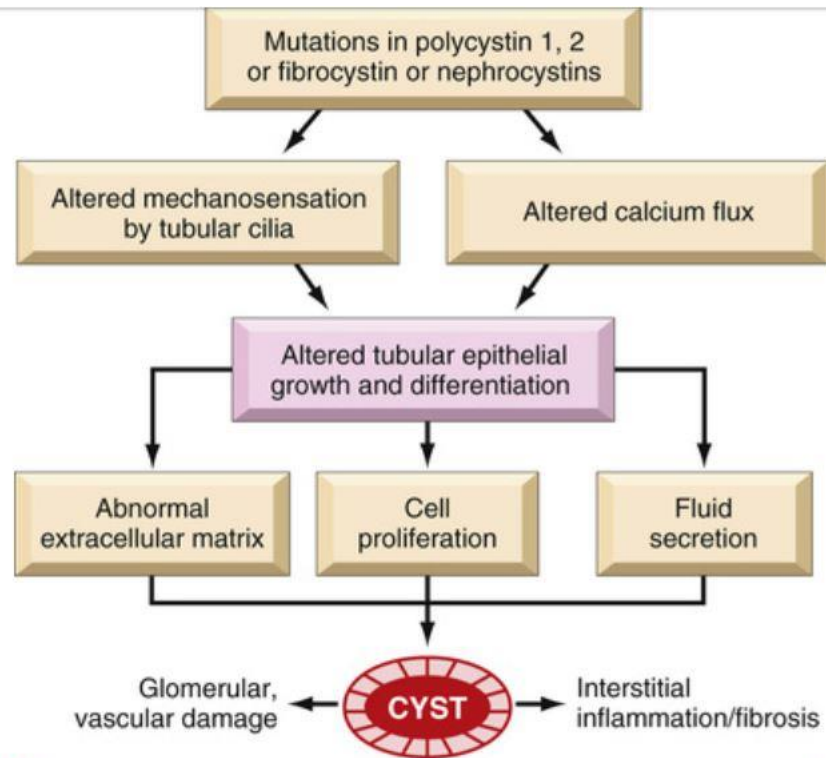
A

B



Polycystic kidney diseases

- **AUTOZOMAL RECESIVE**
- **AUTOZOMAL DOMINANT**
 - 10 % of patients with chronic kidney failure

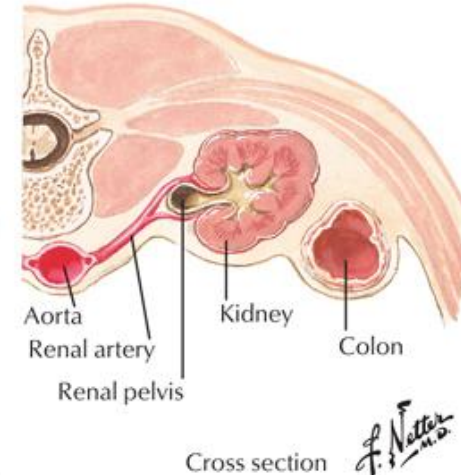
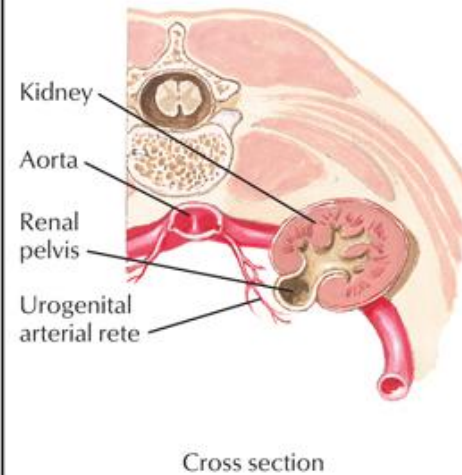
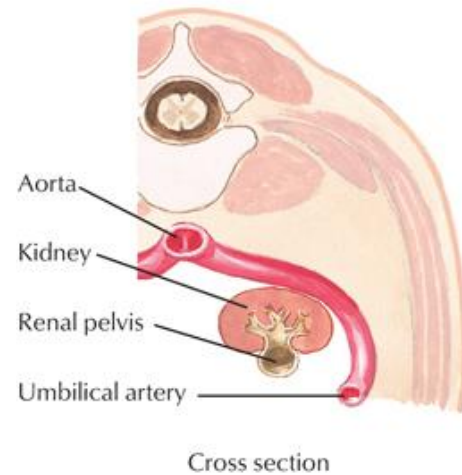
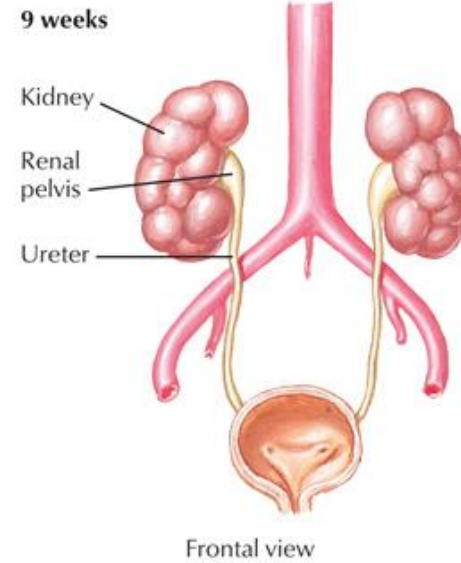
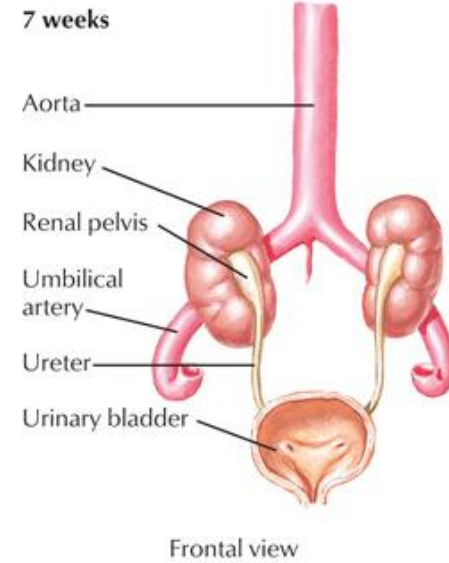
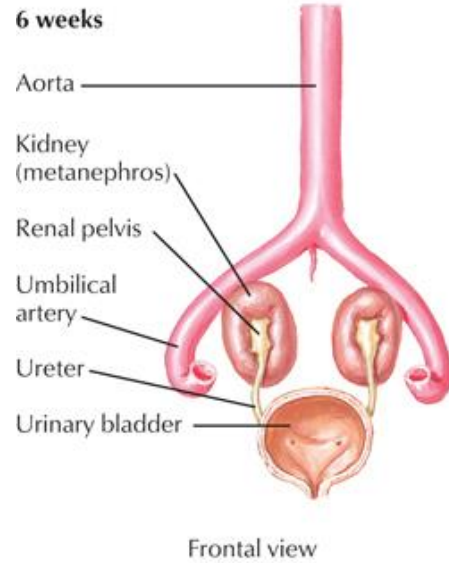


Kumar, Vinay, et al. *Robbins Basic Pathology*. Available from: Elsevier eBooks+, (10th Edition). Elsevier - OHCE, 2017.

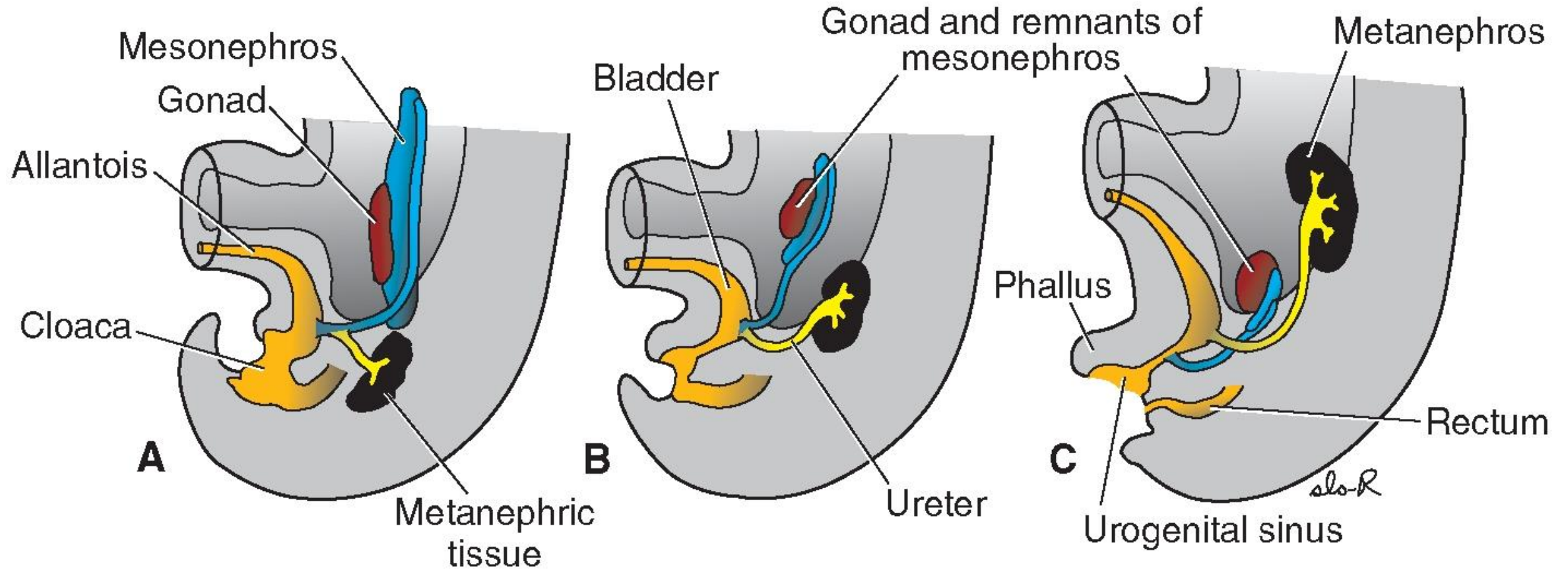
FIG. 14.21 Possible mechanisms of cyst formation in cystic kidney diseases (see text).

Ascent and rotation of the metanephros

Apparent "ascent and rotation" of the kidneys in embryological development



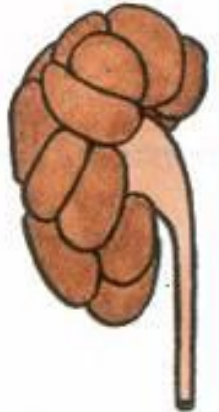
Ascent and rotation of the metanephros



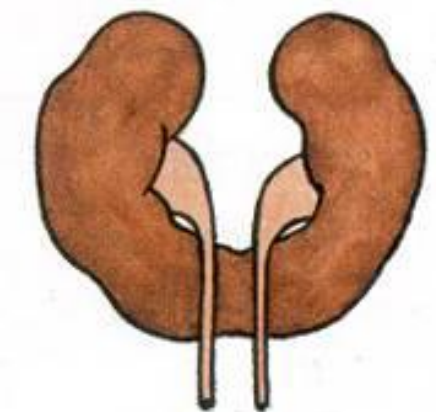
Renal fusion

Persistent fetal lobulation

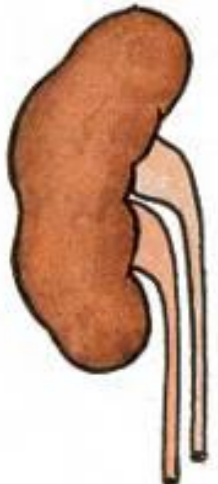
ren renculisatus



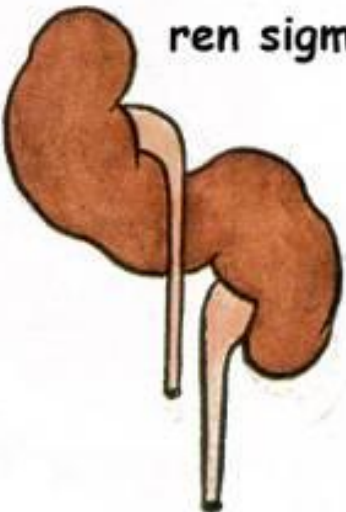
Horseshoe kidney



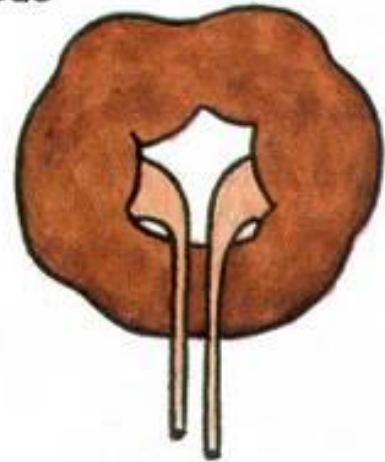
ren arcuatus
podkovovitá ledvina
horseshoe kidney



ren duplex
Duplication of ureters



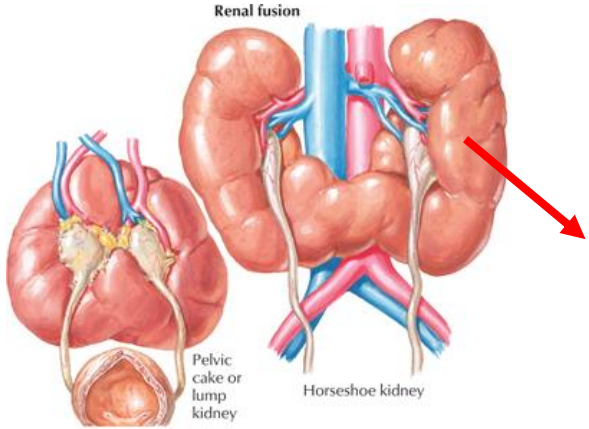
ren sigmoideus



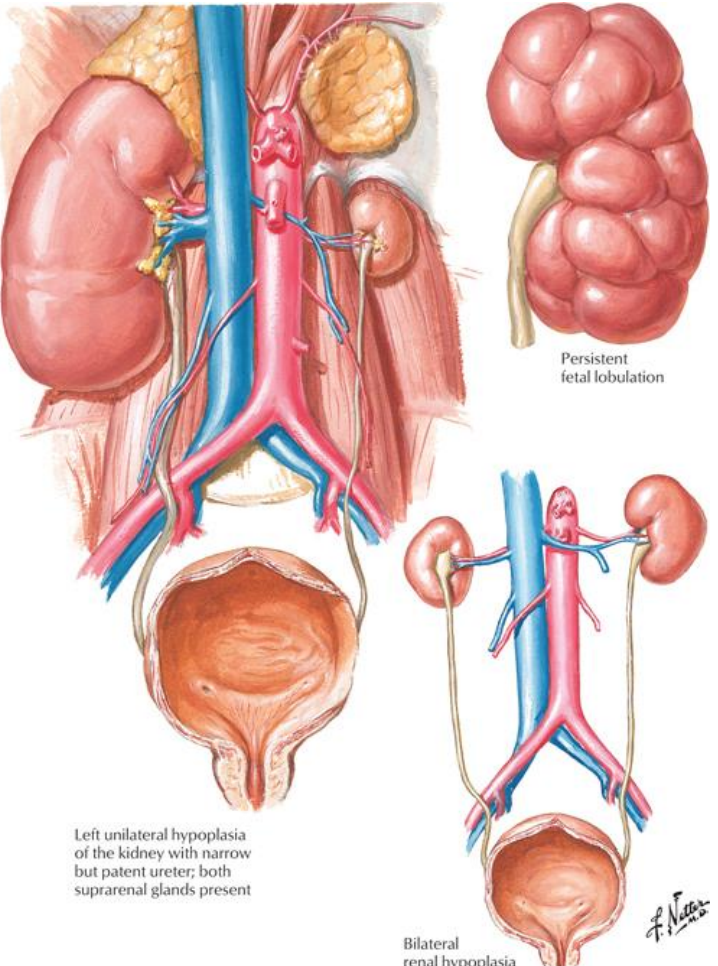
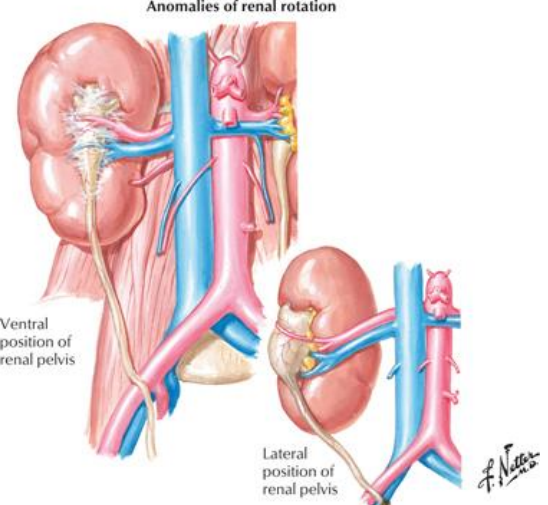
Pelvic cake or lump kidney

ren fungiformis

Renal fusion, rotation anomalies, hypoplasia, agenesis



Horseshoe kidney

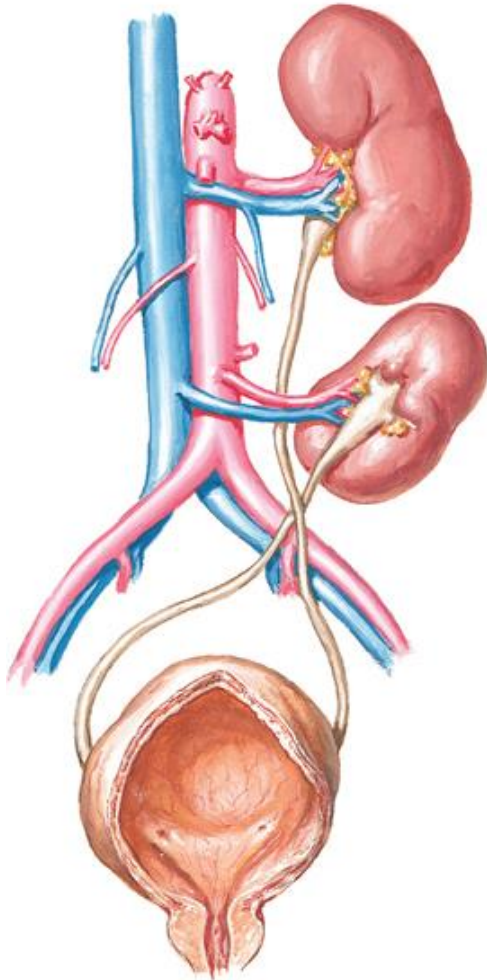


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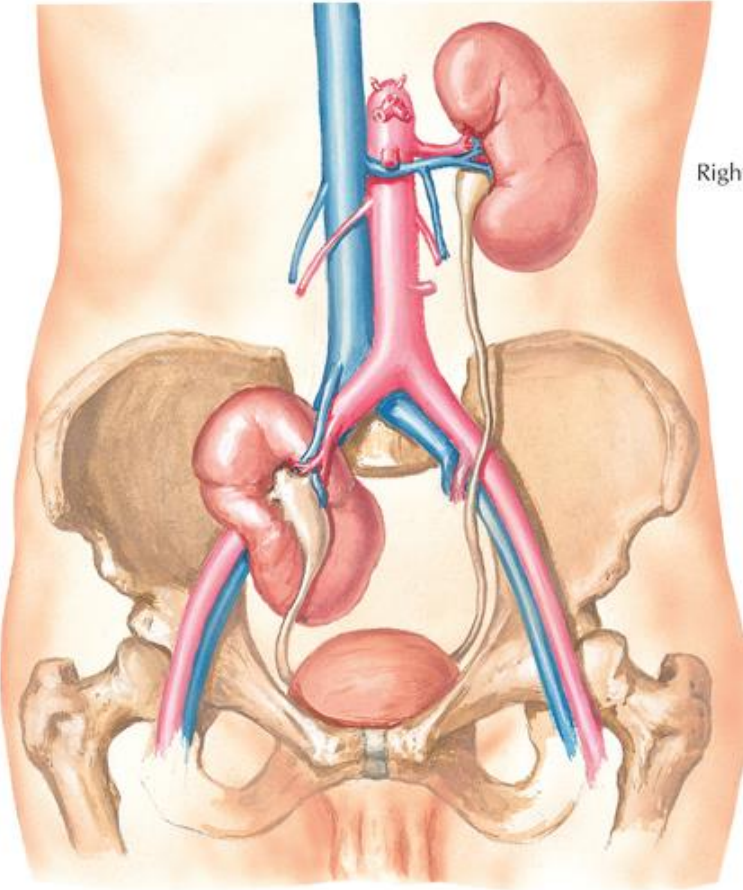
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Ectopic kidney

Ectopia of the kidney



Crossed ectopia of the right kidney



Right pelvic kidney

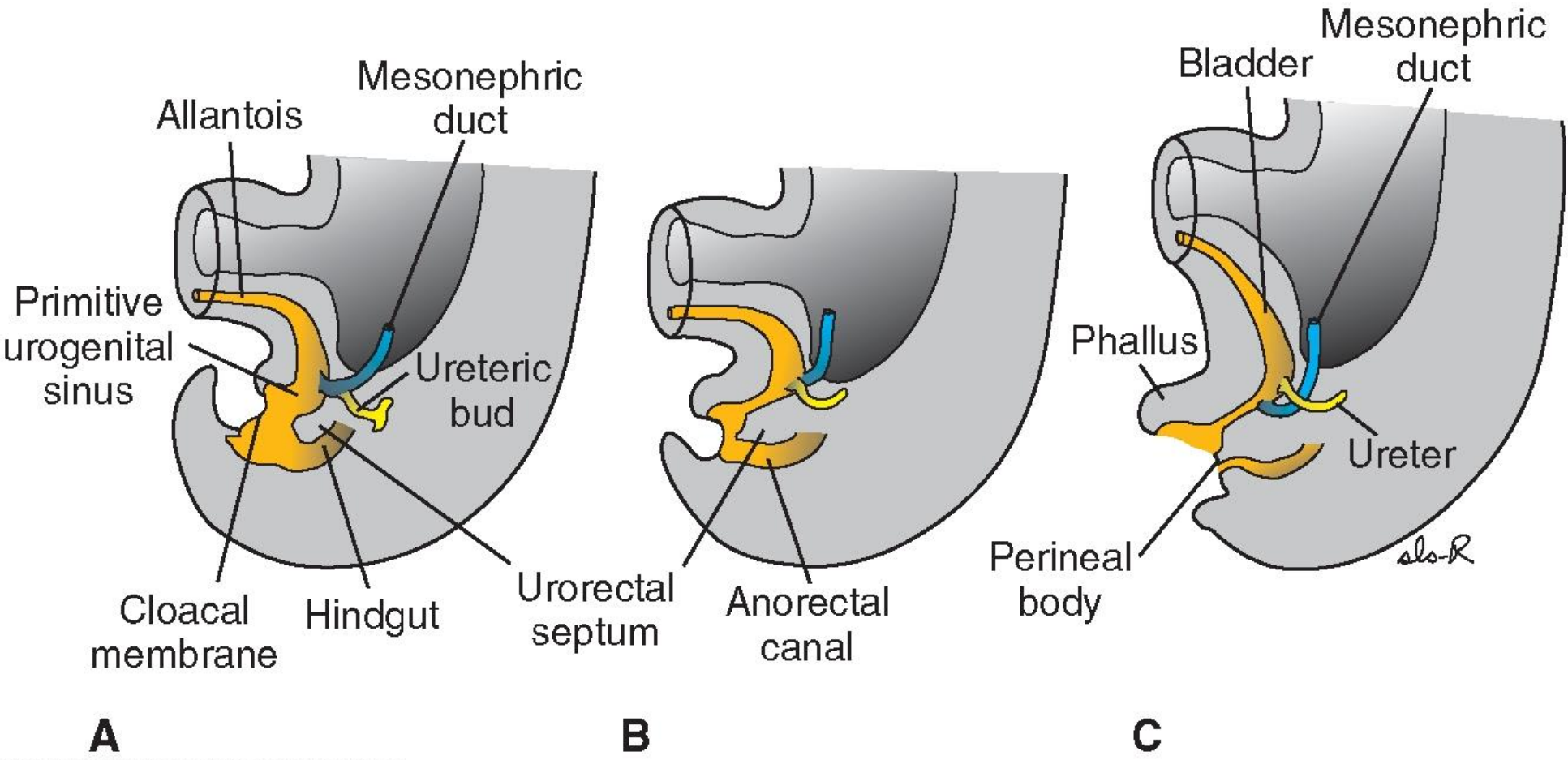
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Ren migrans



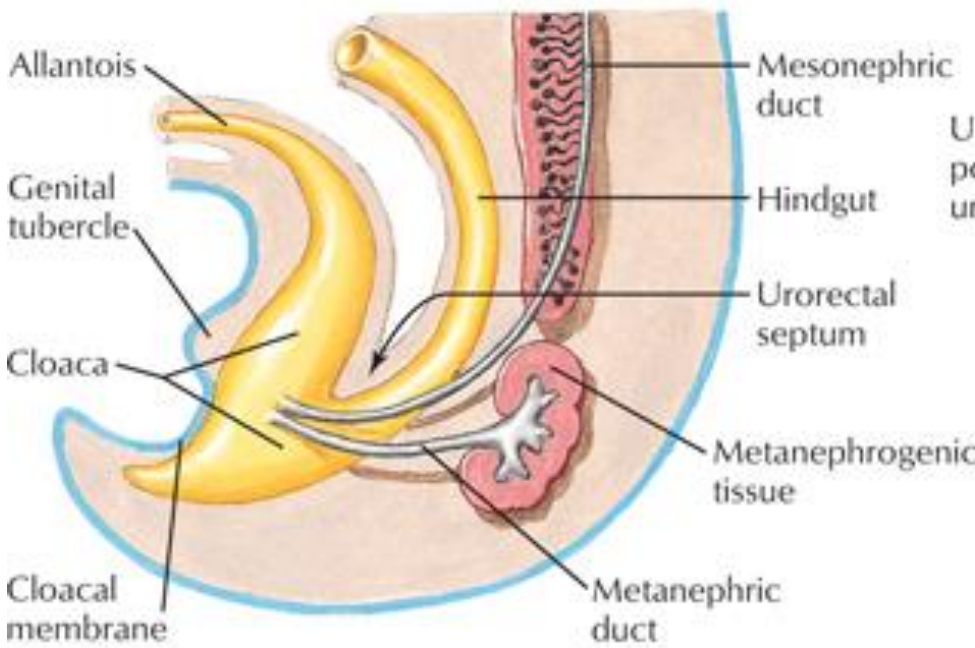
Case courtesy of Sami Elhinnawi, Radiopaedia.org, rID: 56632

Division of cloaca – urorectal septum

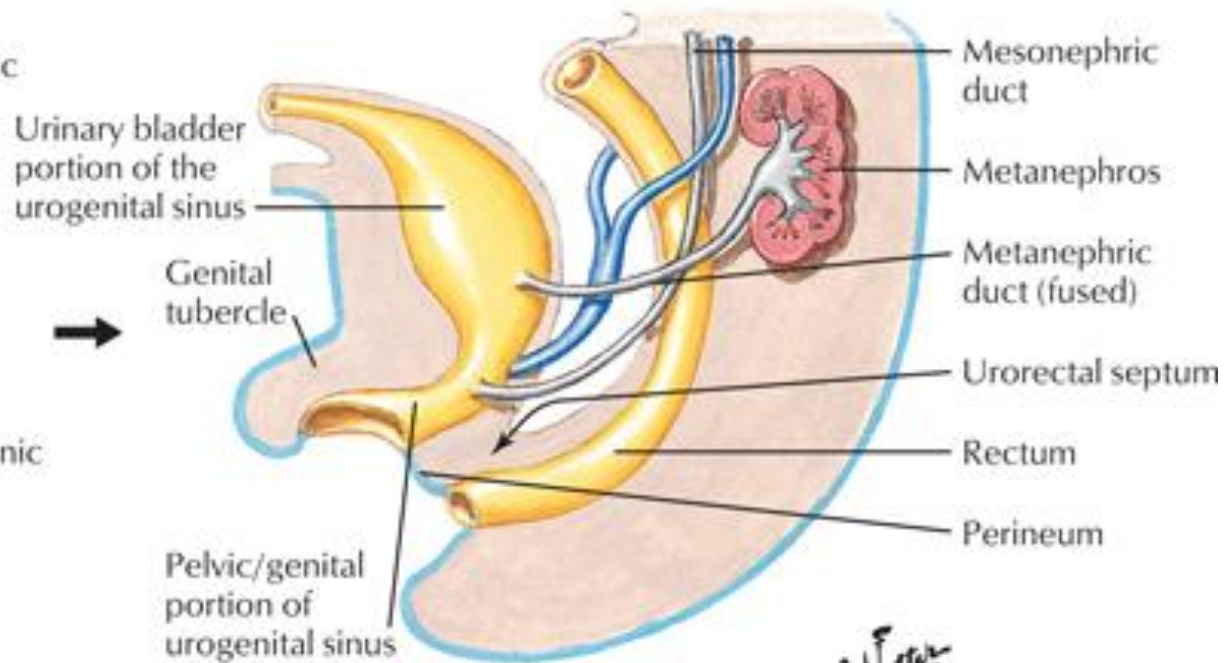


Division of cloaca – urorectal septum

Division of the cloaca by the urorectal septum



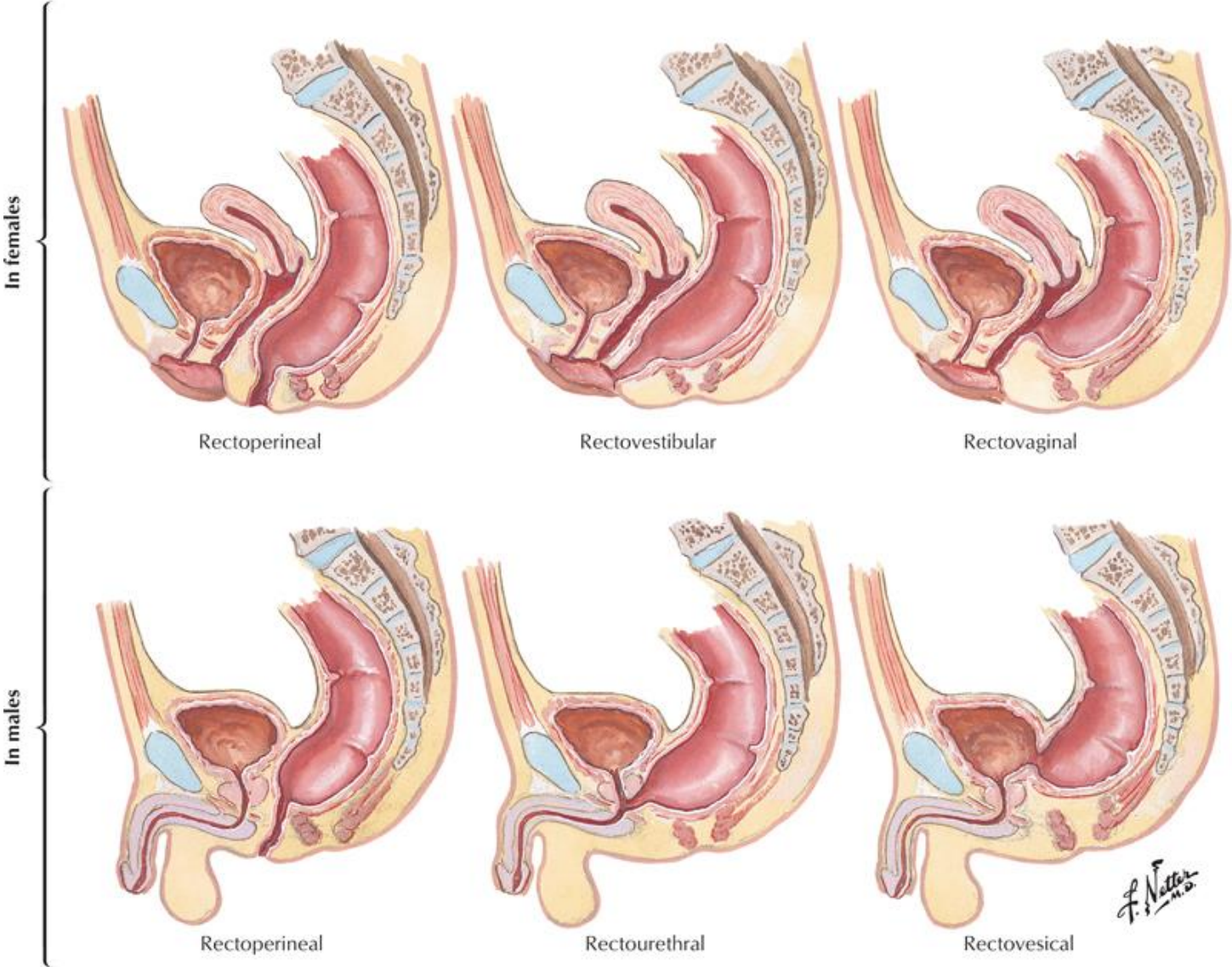
Urogenital sinus and rectum



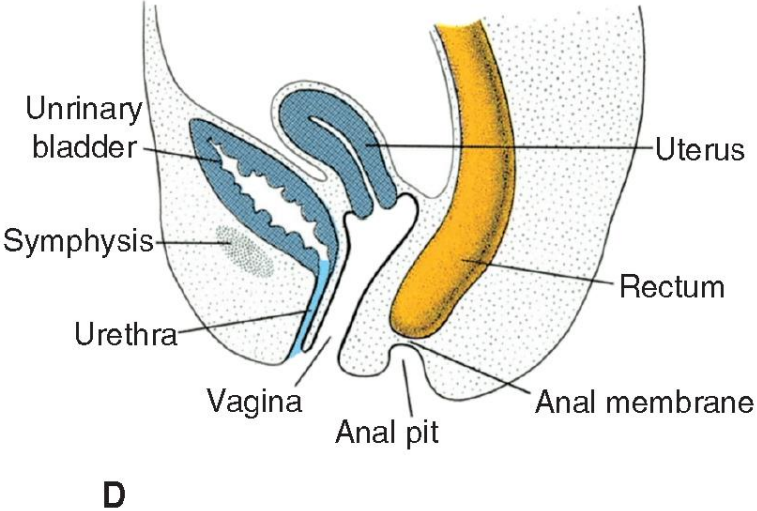
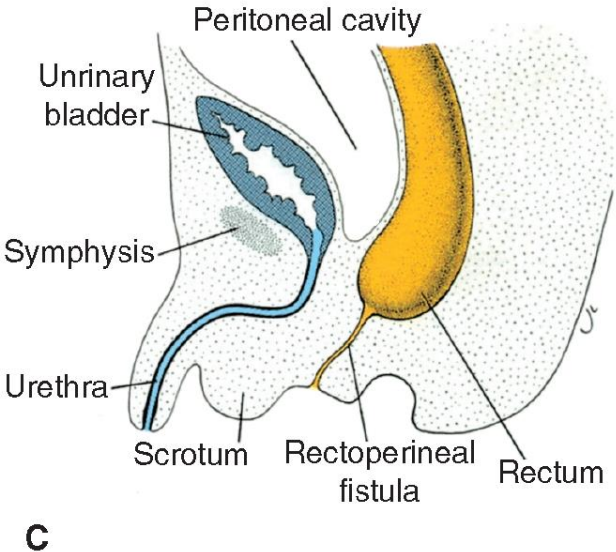
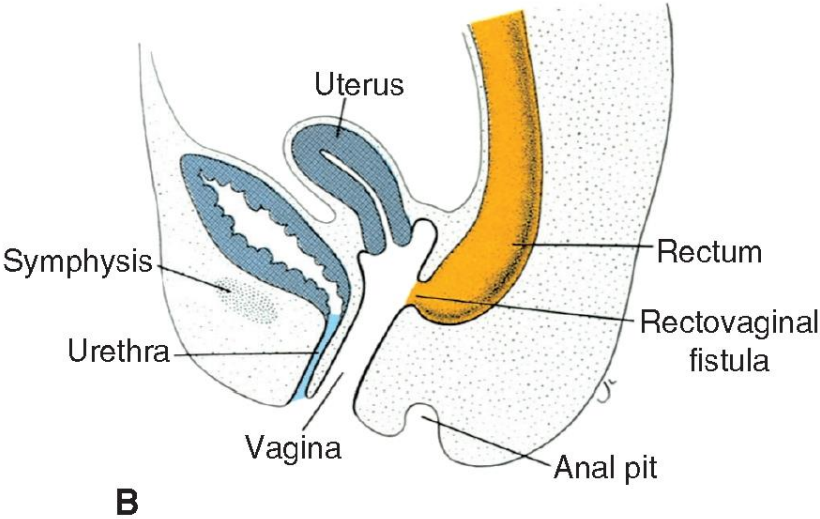
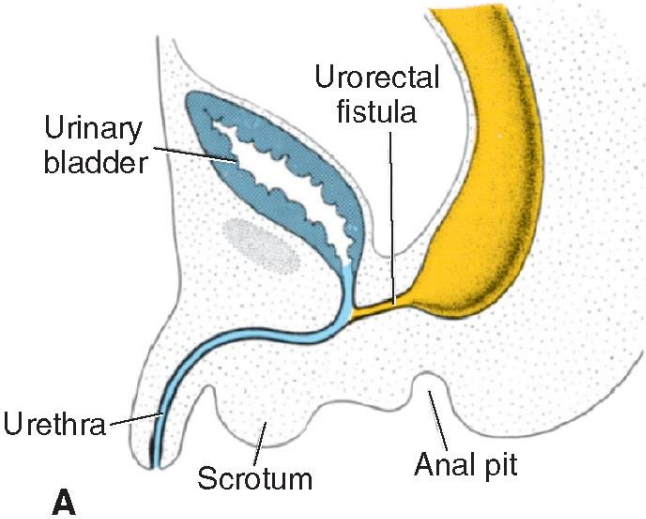
F. Netter M.D.

Congenital cloacal anomalies

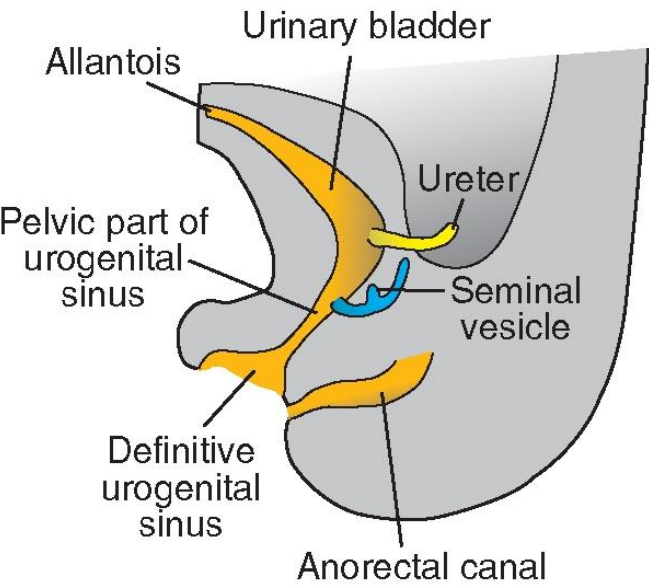
Fistulas resulting from the incomplete division of the cloaca



Congenital cloacal anomalies

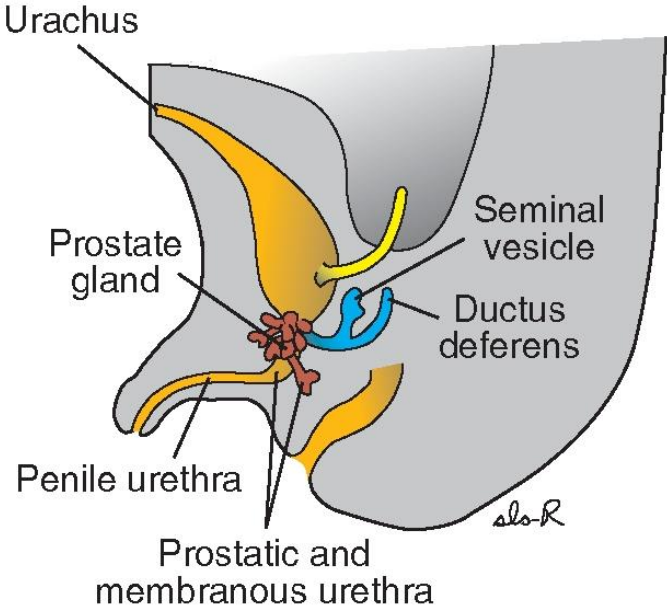


Ureter, urinary bladder



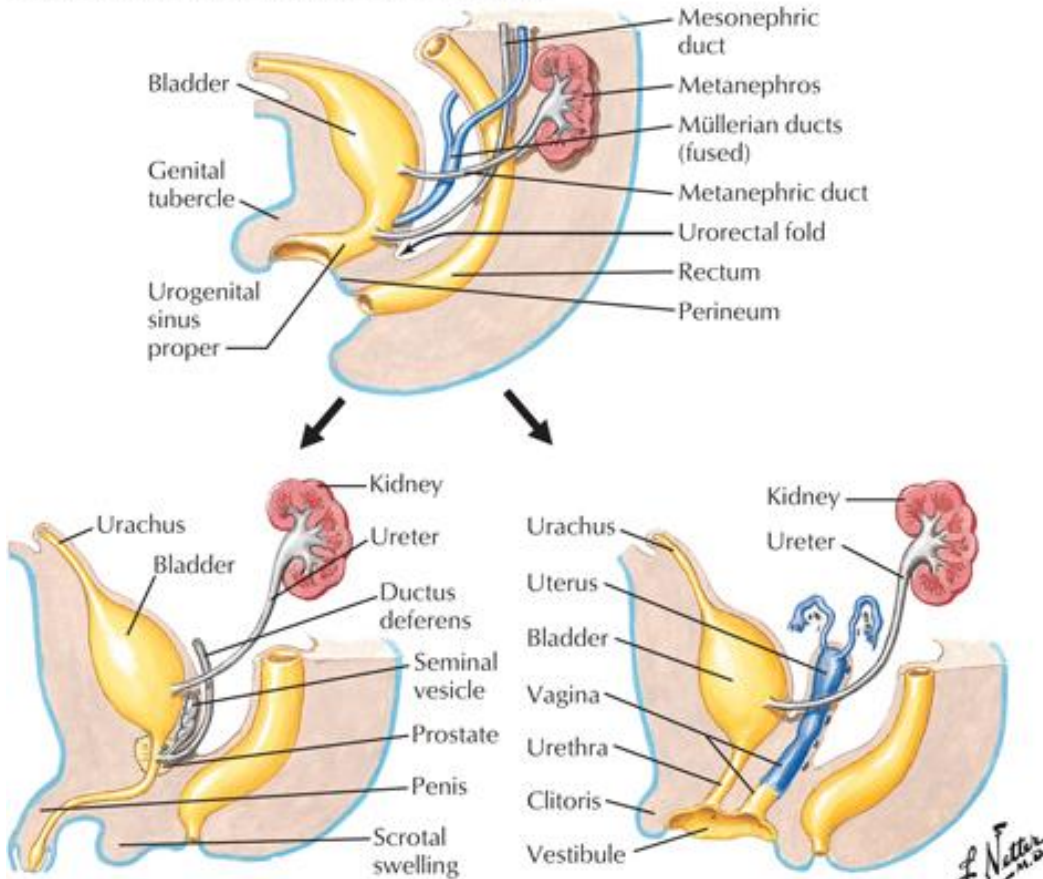
A

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B

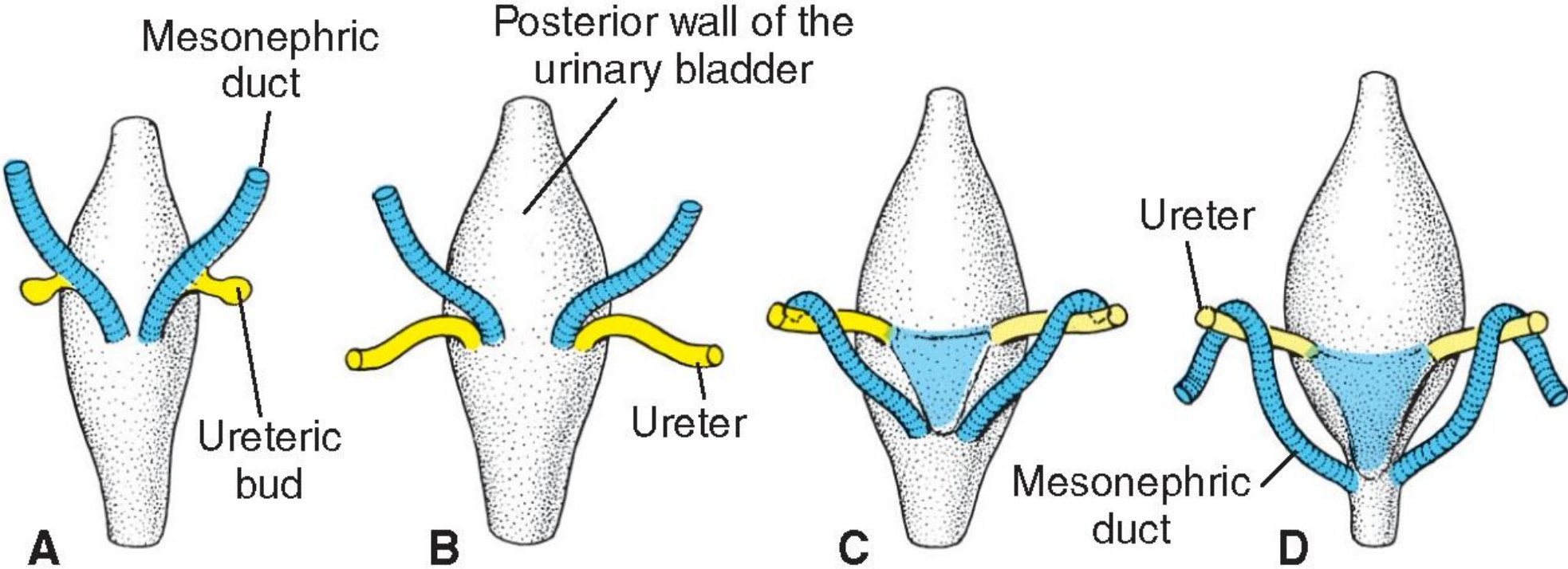
Lateral view (both sexes have identical primordia)



Male Female

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Ureter, urinary bladder, ductus mesonephricus

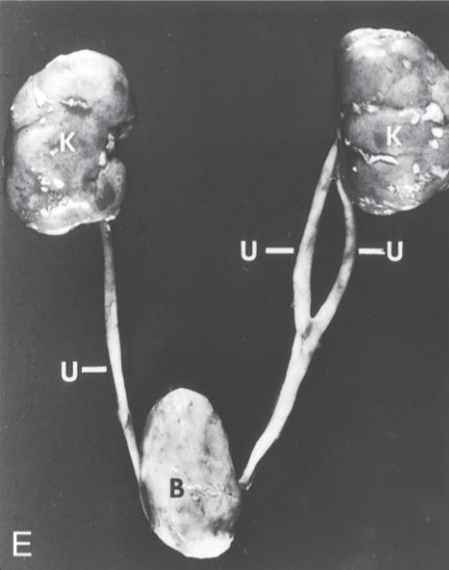
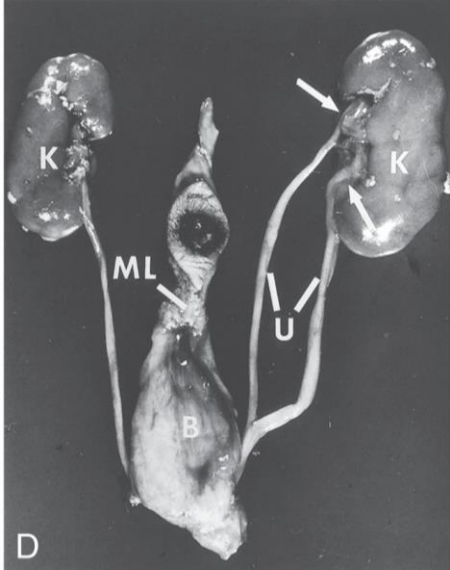
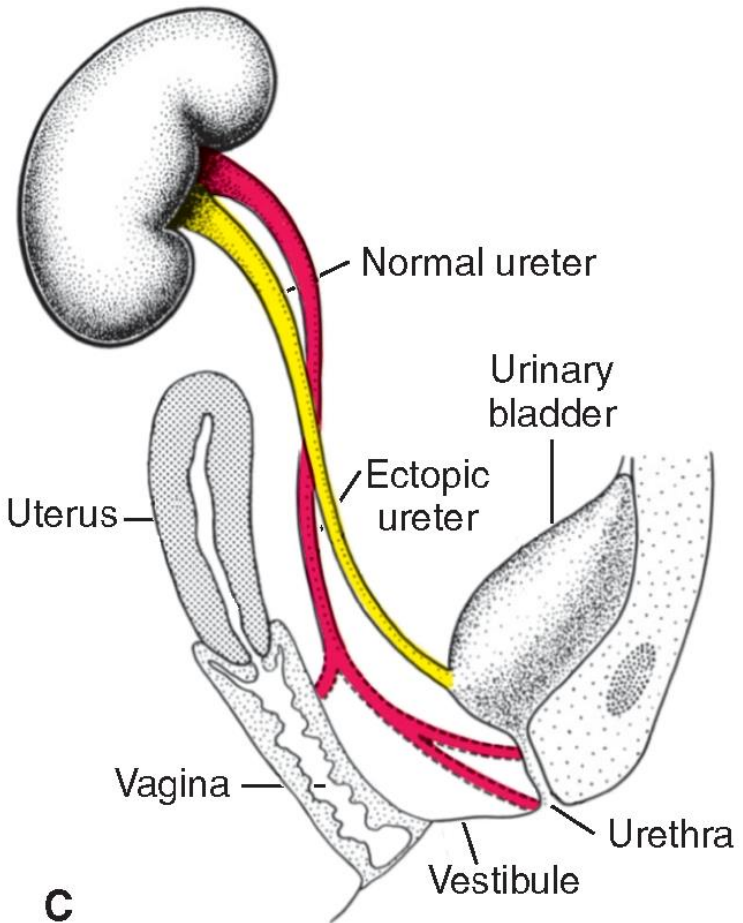
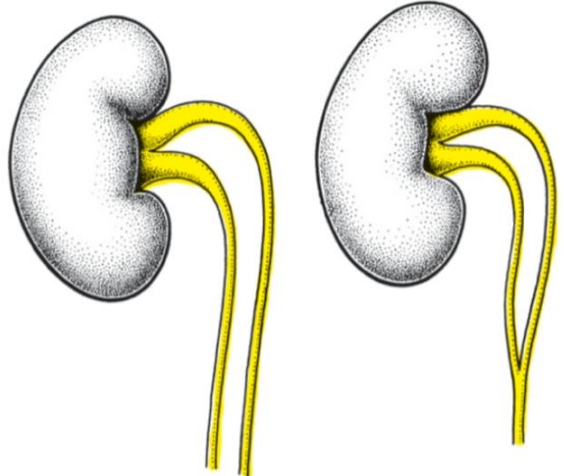


Ureteric bud duplication, ectopic ureters

Ureter duplex

Ureter fissus

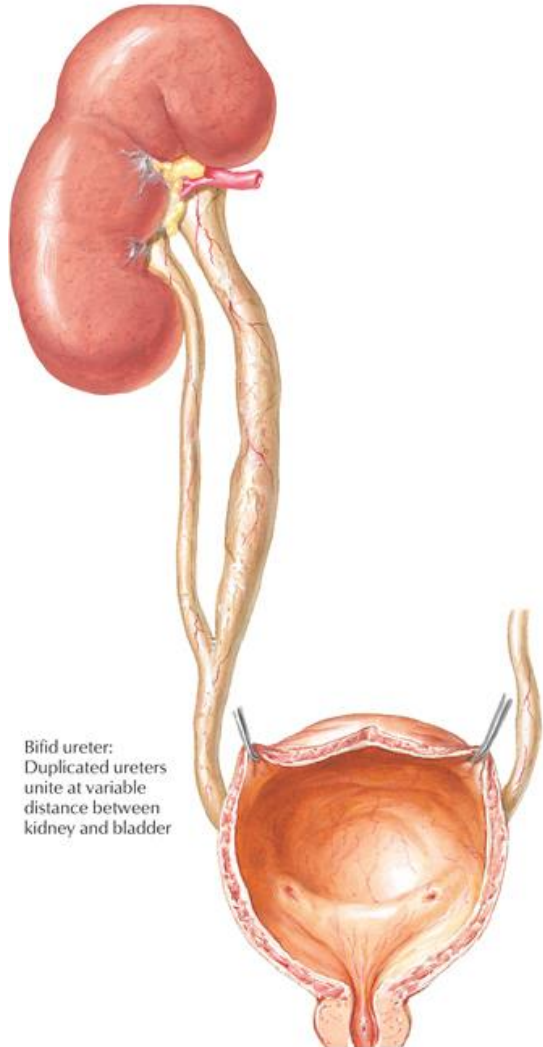
Ectopic ureters



Ureteric bud duplication, ectopic ureters

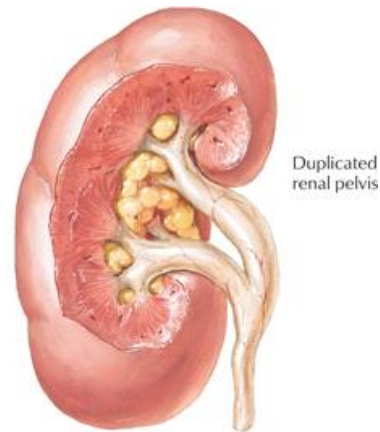
Fistula congenita vesicouterina/vesicovaginalis

Incomplete duplication of ureter



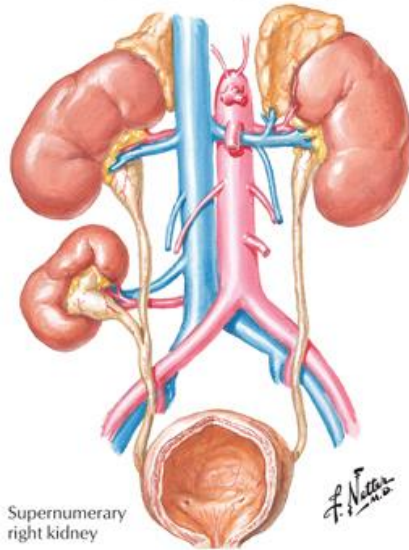
Bifid ureter: Duplicated ureters unite at variable distance between kidney and bladder

Anomalies of renal pelvis and calyces



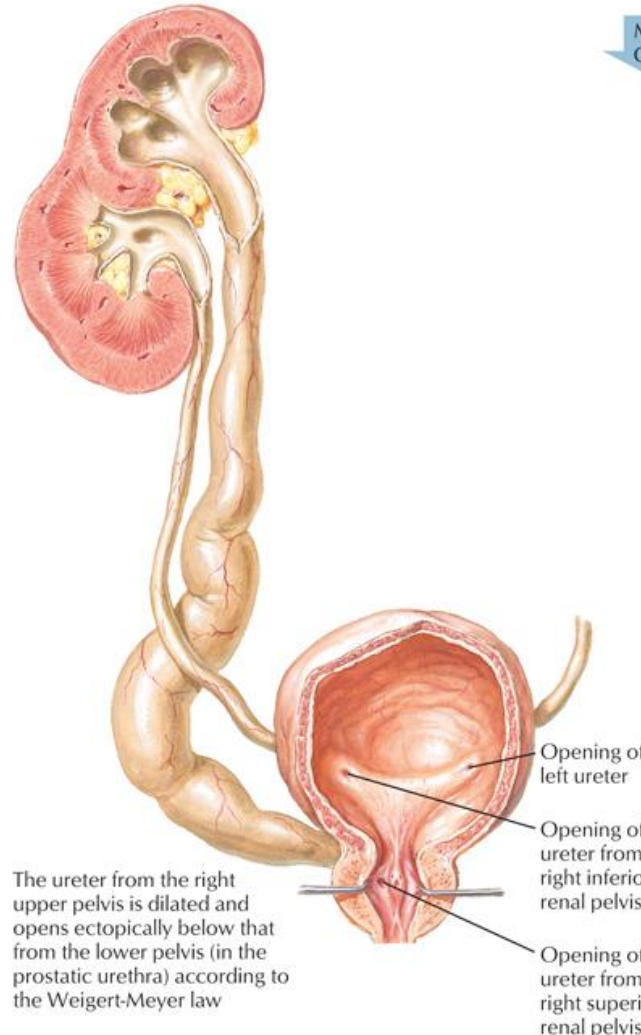
Duplicated renal pelvis

Anomalies in number of kidneys



Supernumerary right kidney

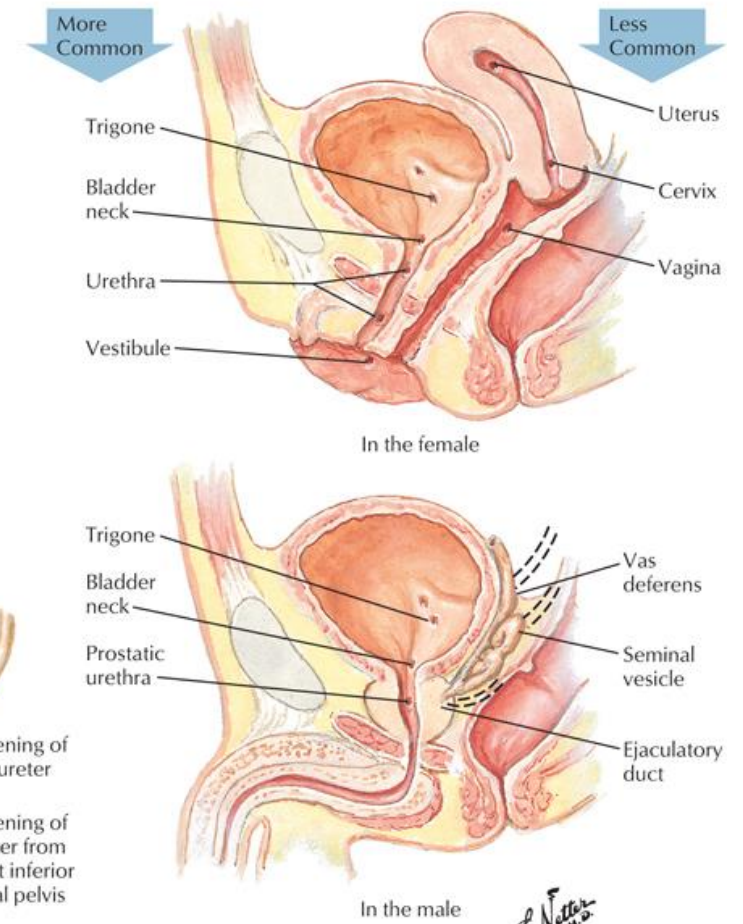
Complete duplication of the ureter



The ureter from the right upper pelvis is dilated and opens ectopically below that from the lower pelvis (in the prostatic urethra) according to the Weigert-Meyer law

Opening of left ureter
Opening of ureter from right inferior renal pelvis
Opening of ureter from right superior renal pelvis

Observed sites of ectopic ureteral orifices



More Common

Less Common

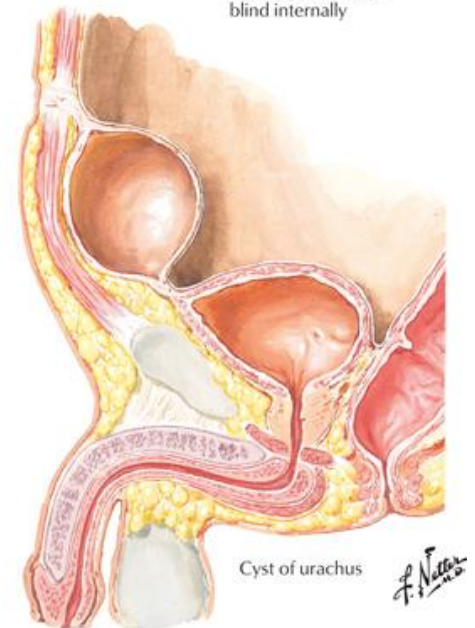
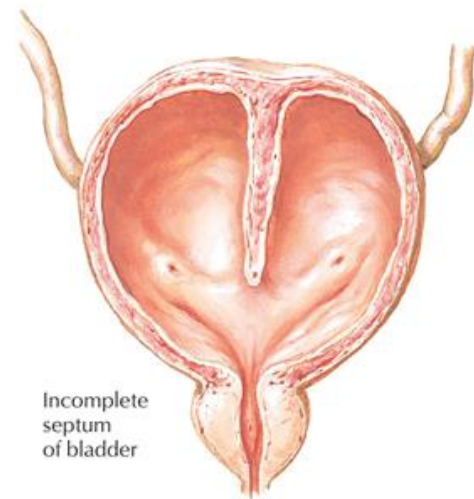
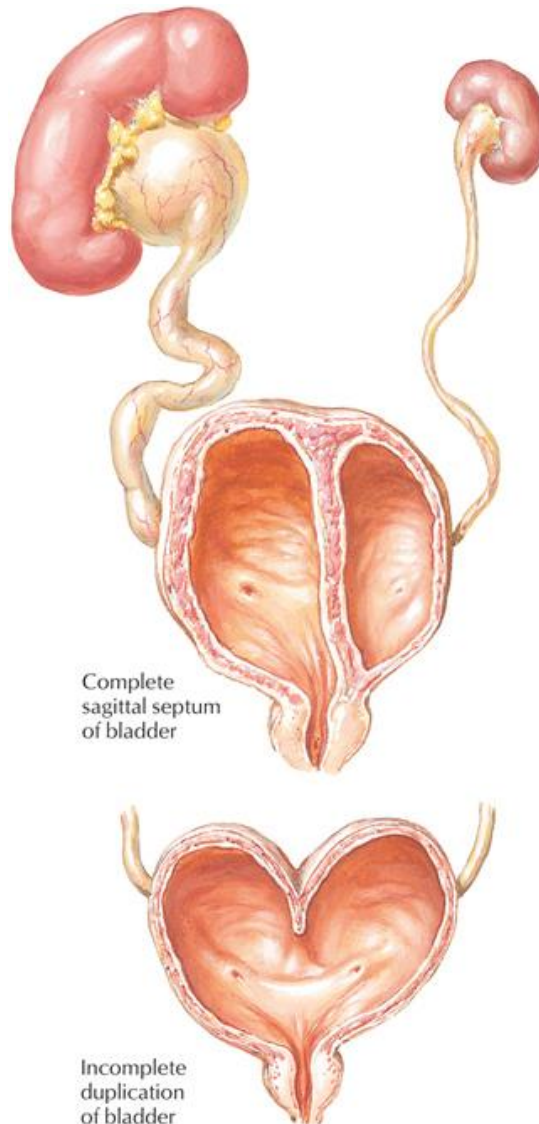
Trigone
Bladder neck
Urethra
Vestibule
Uterus
Cervix
Vagina

In the female

Trigone
Bladder neck
Prostatic urethra
Vas deferens
Seminal vesicle
Ejaculatory duct

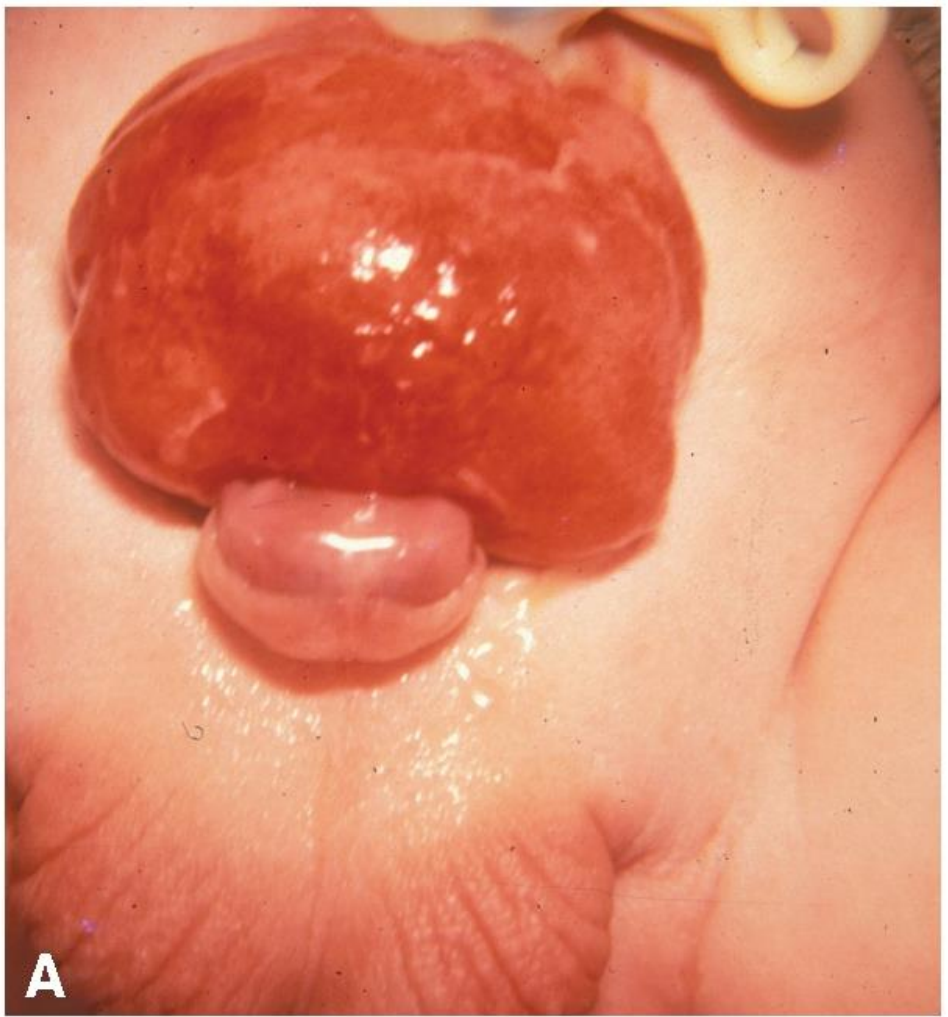
In the male

Bladder anomalies



Bladder anomalies

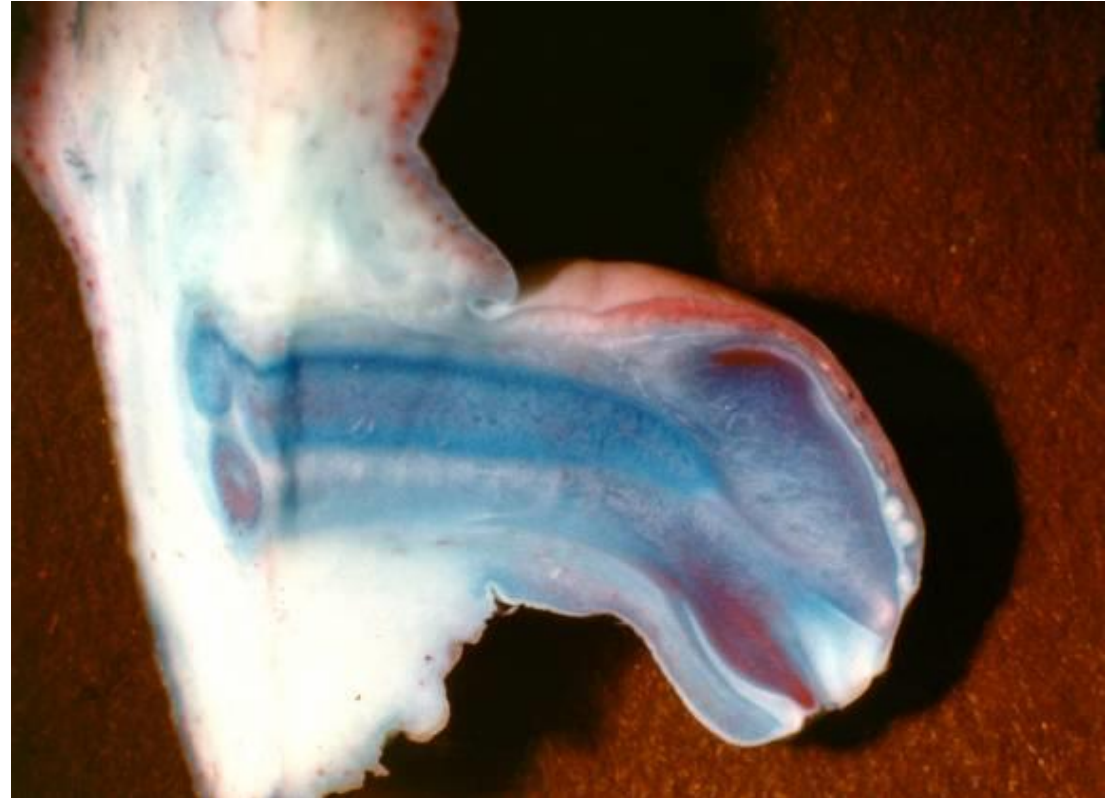
Exstrophy of the bladder



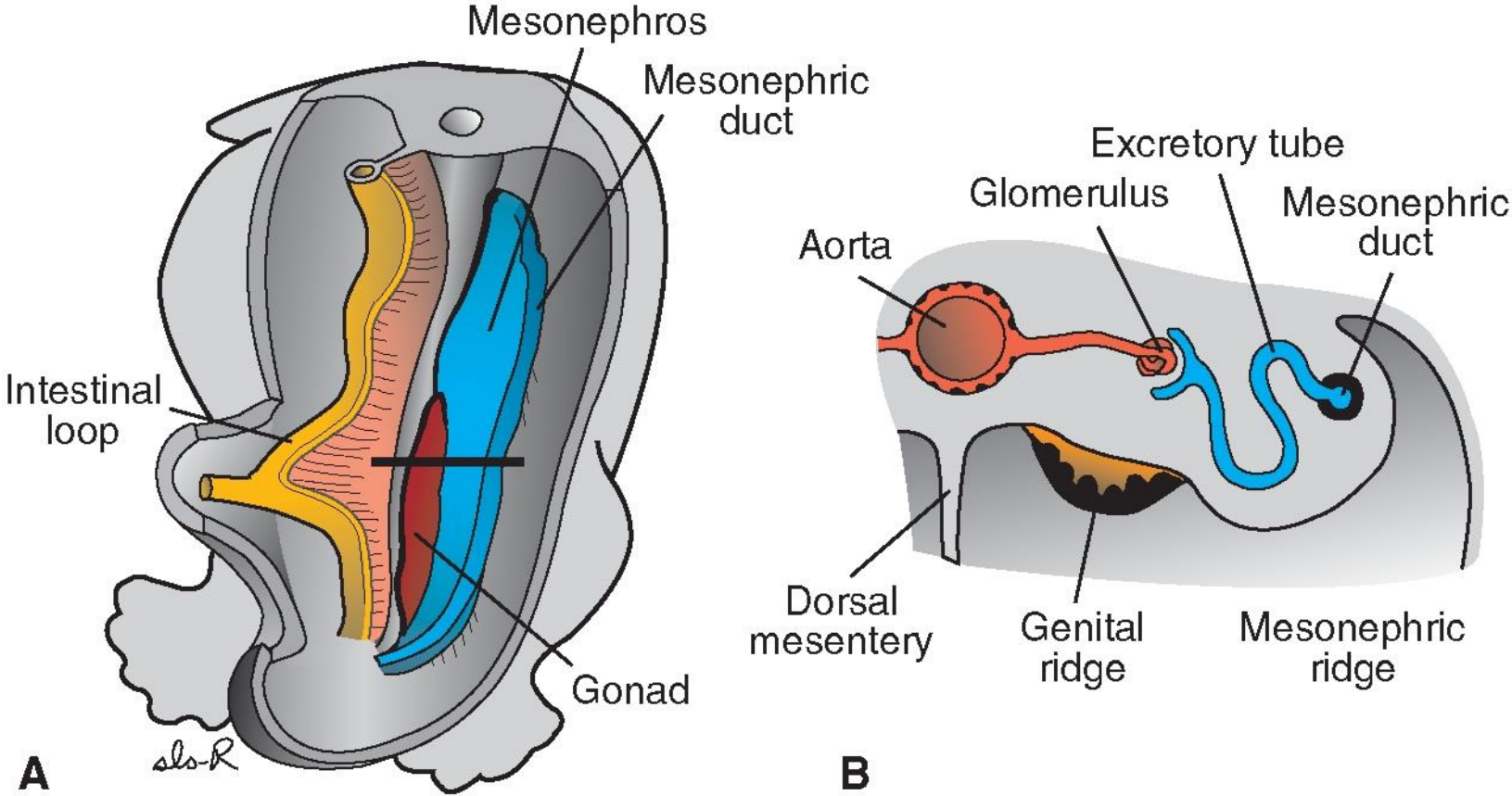
Cloacal exstrophy



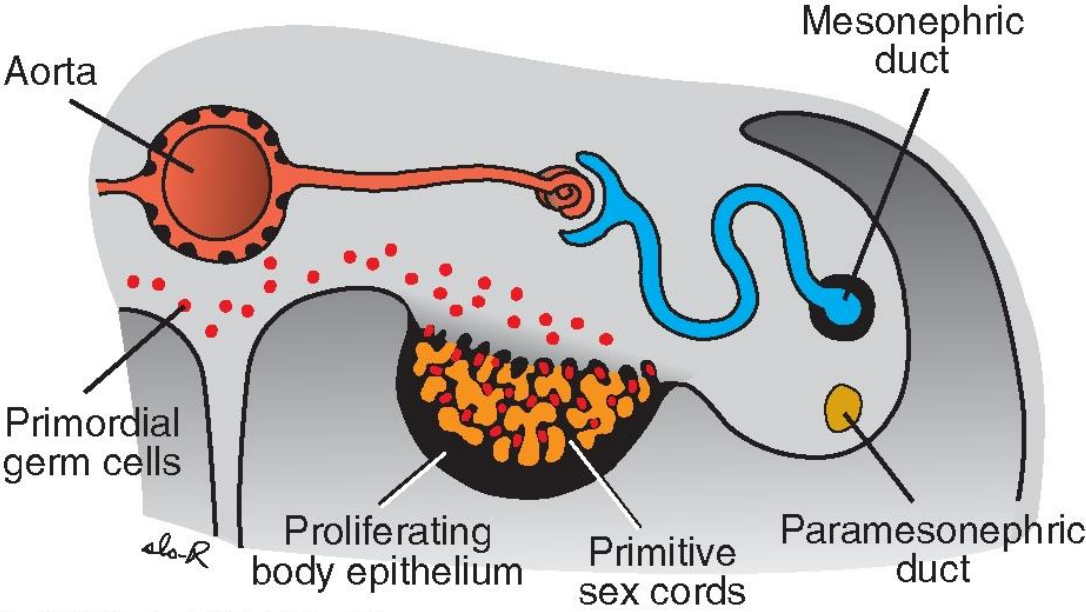
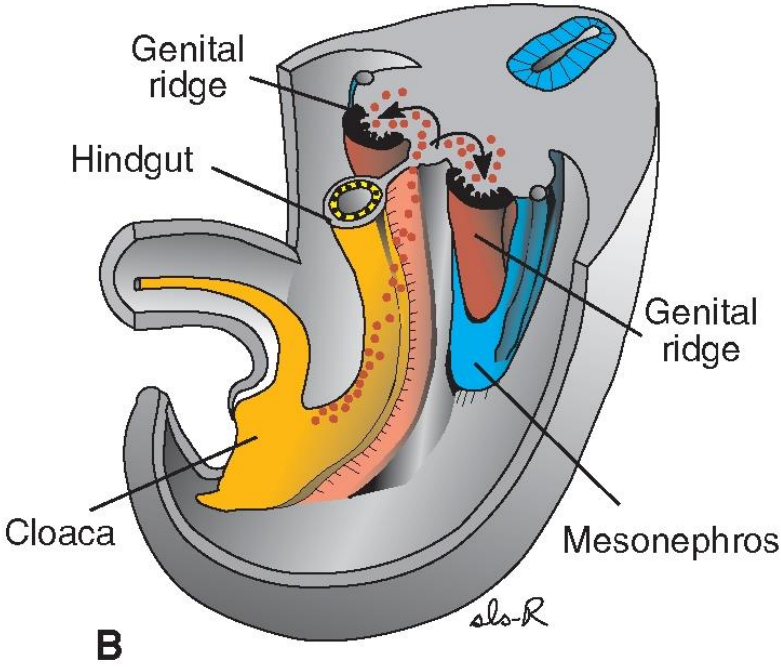
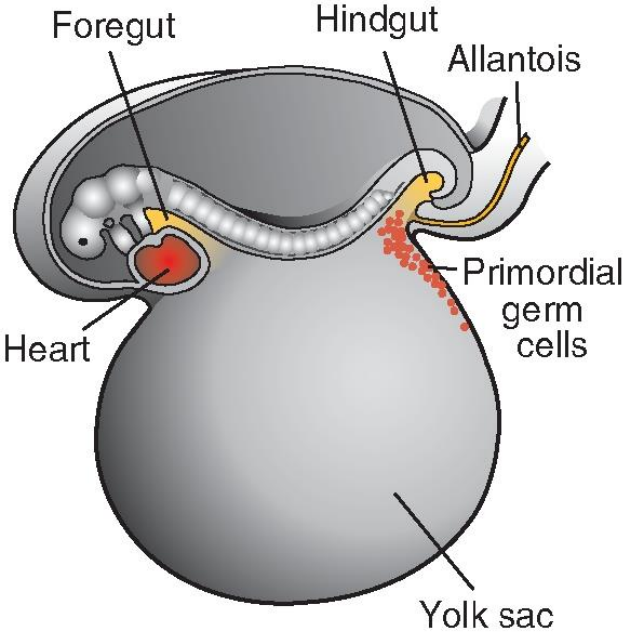
Genital system



Indifferent gonad and genital ducts

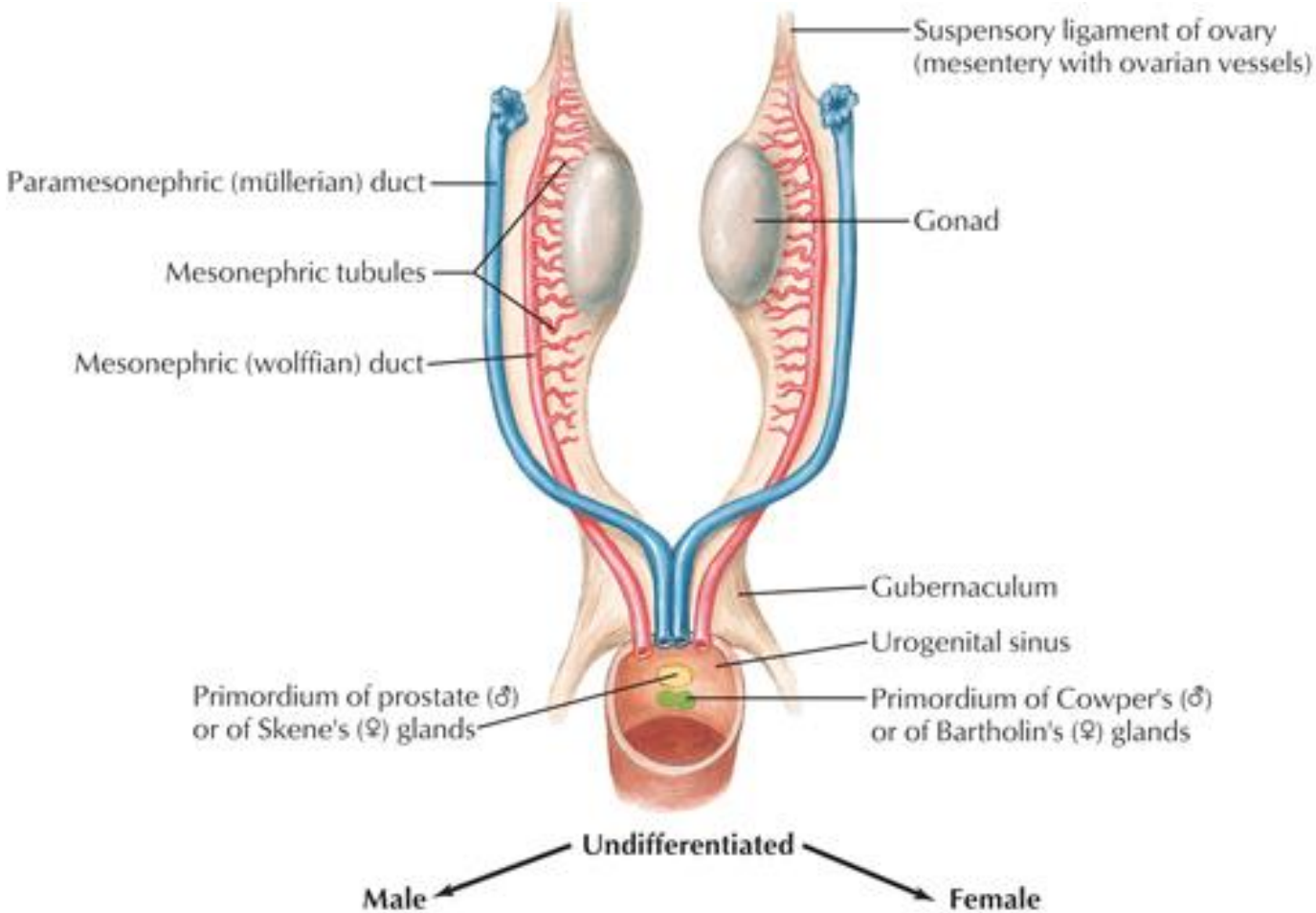


Indifferent gonad and genital ducts

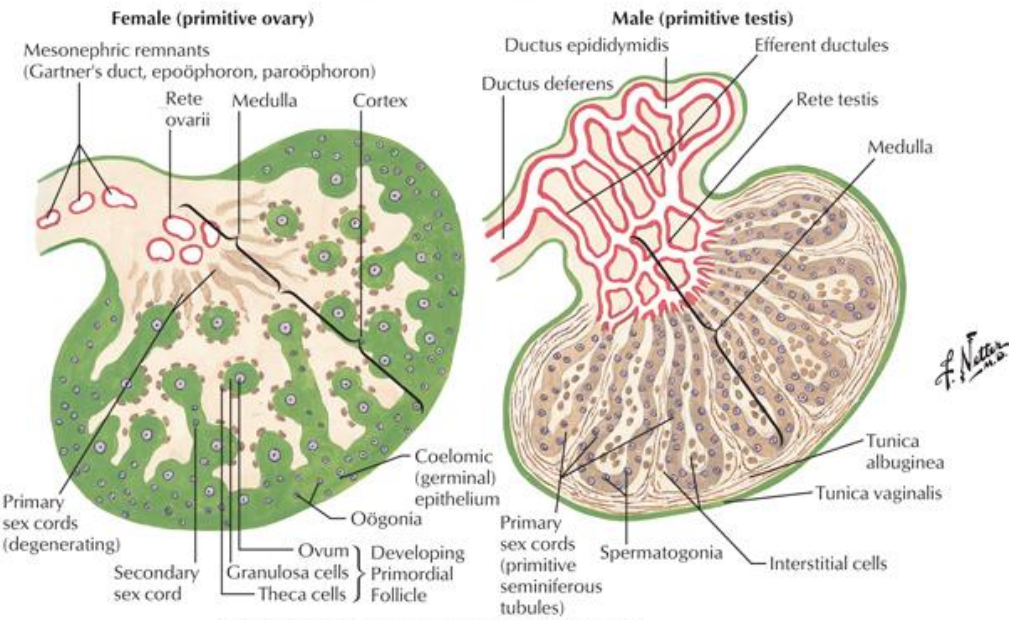
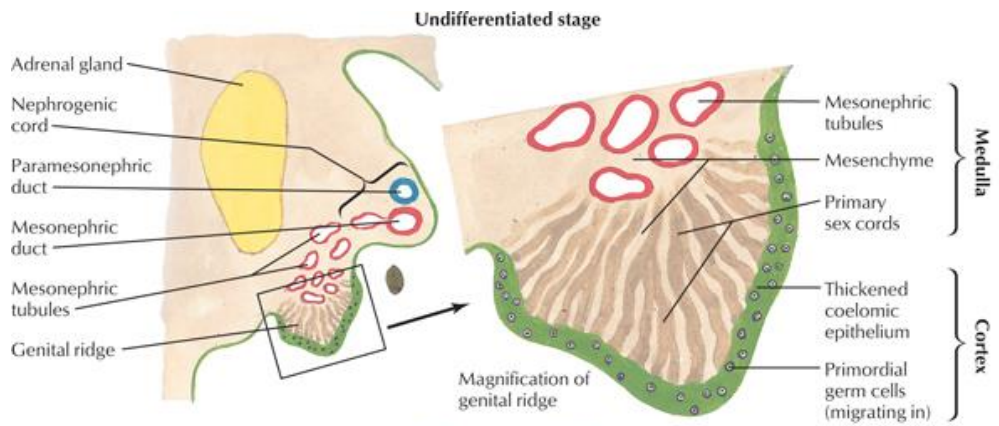


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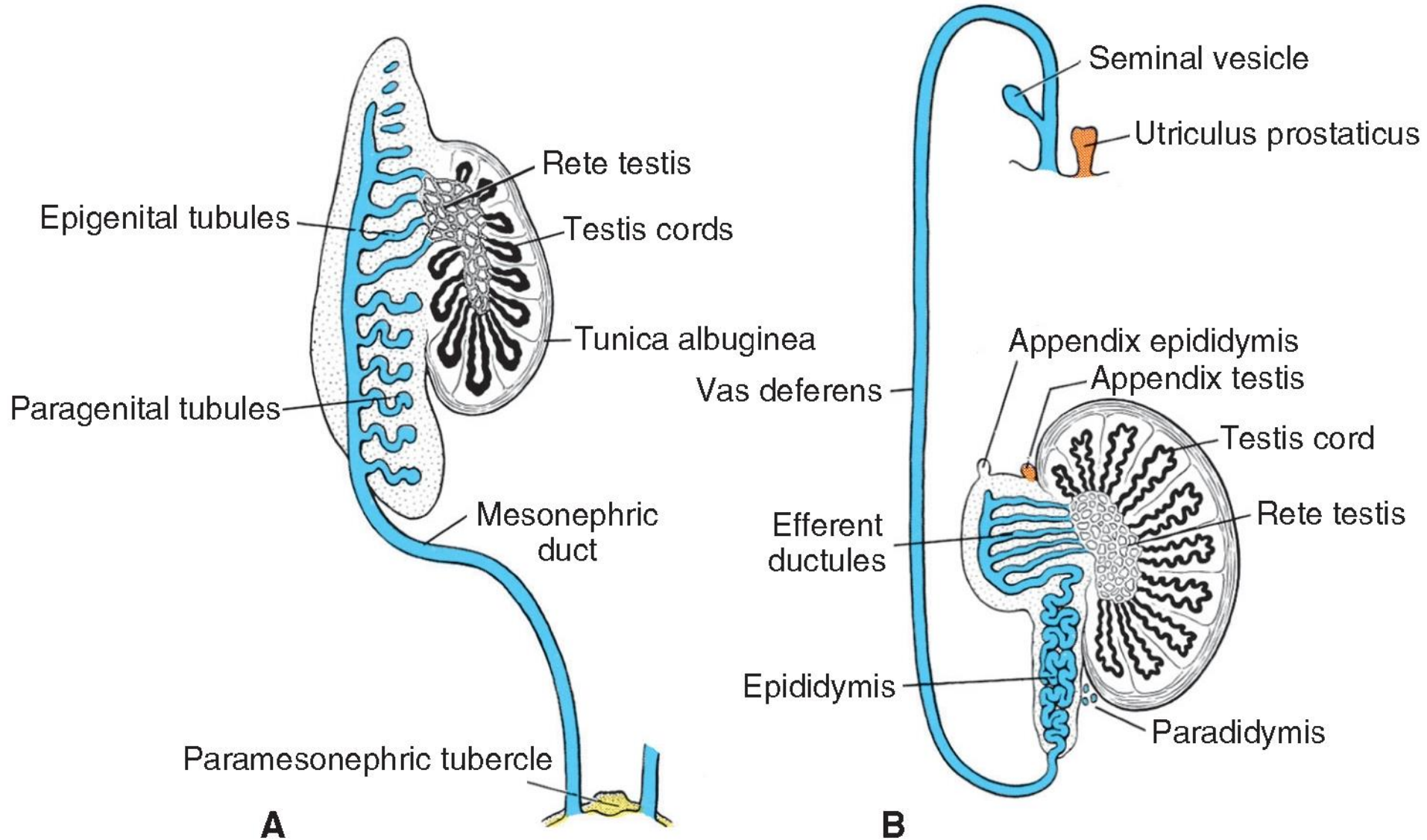
Indifferent gonad and genital ducts



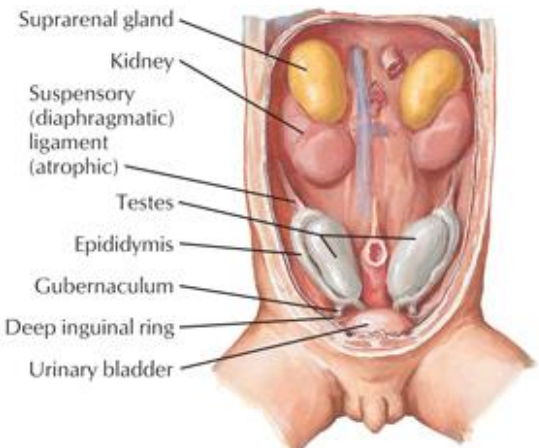
Indifferent gonad and genital ducts



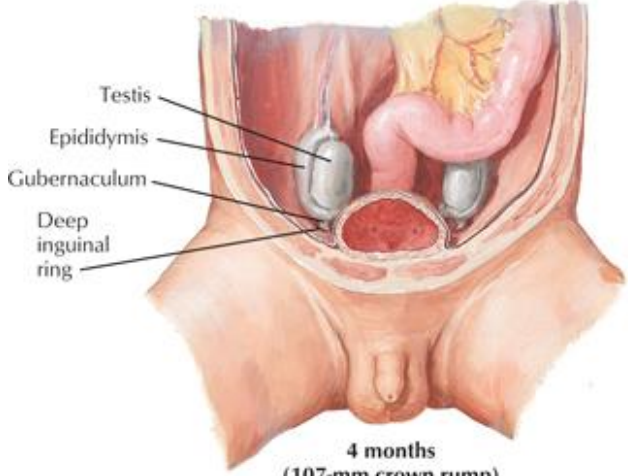
Testis, epididymis and ductus deferens



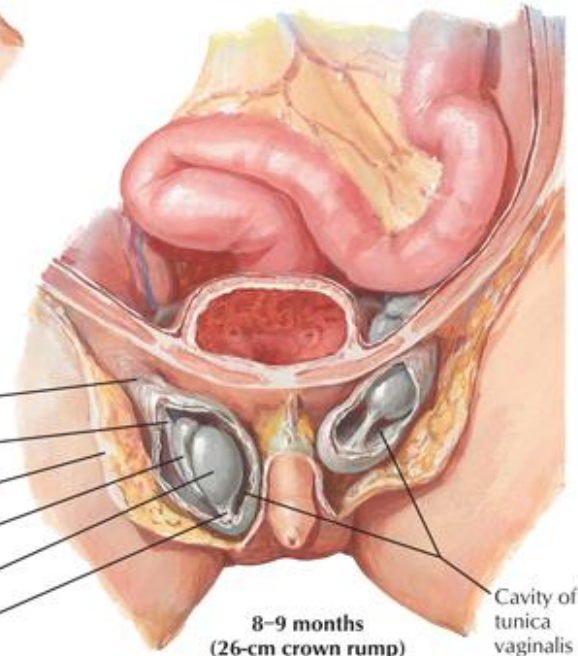
Descent of testis



**11 weeks
(43-mm crown rump)**



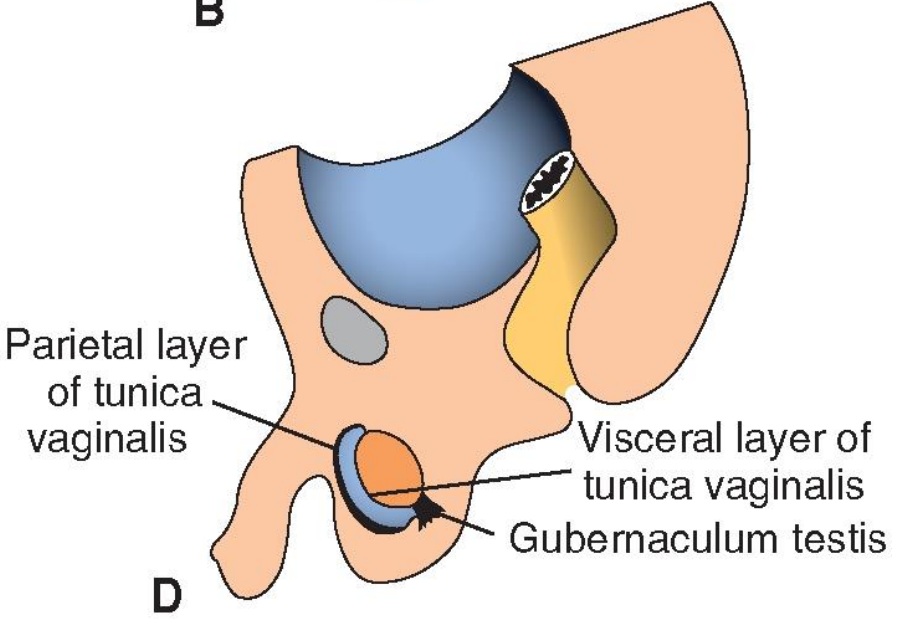
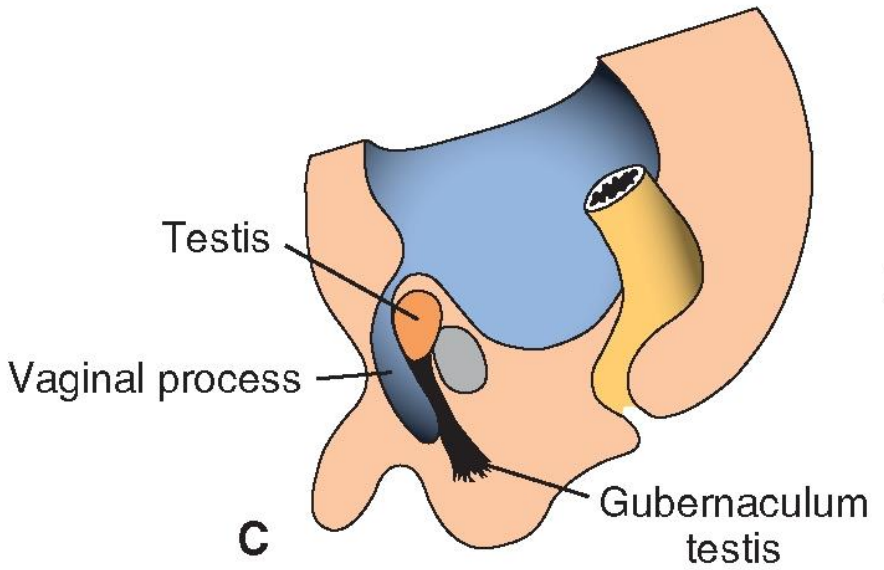
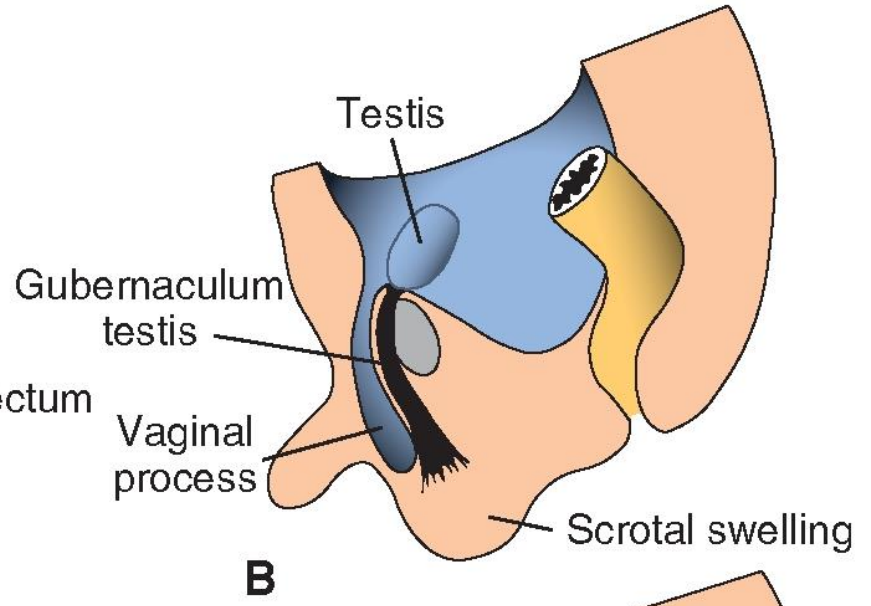
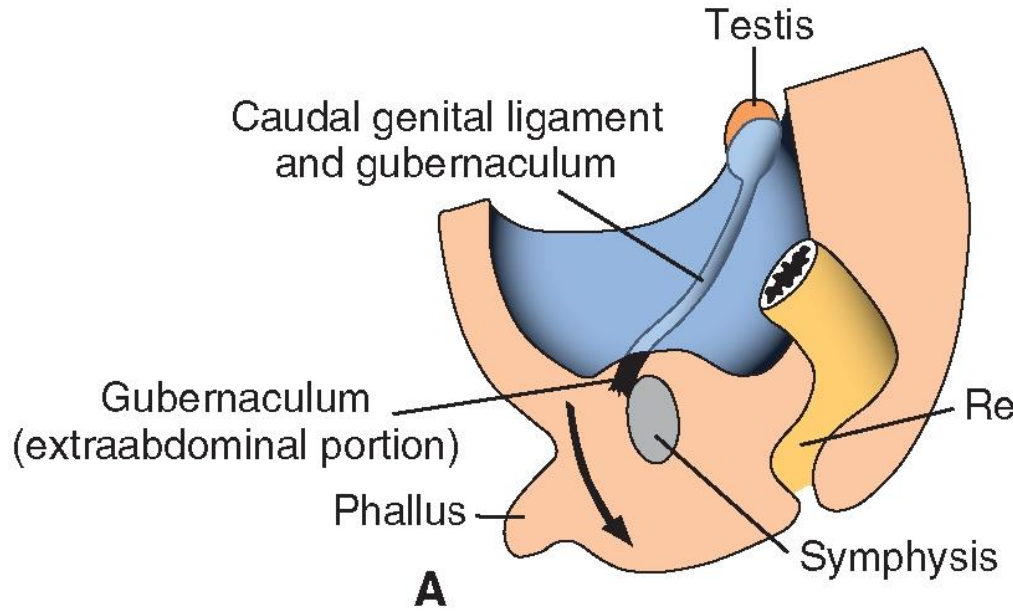
**4 months
(107-mm crown rump)**



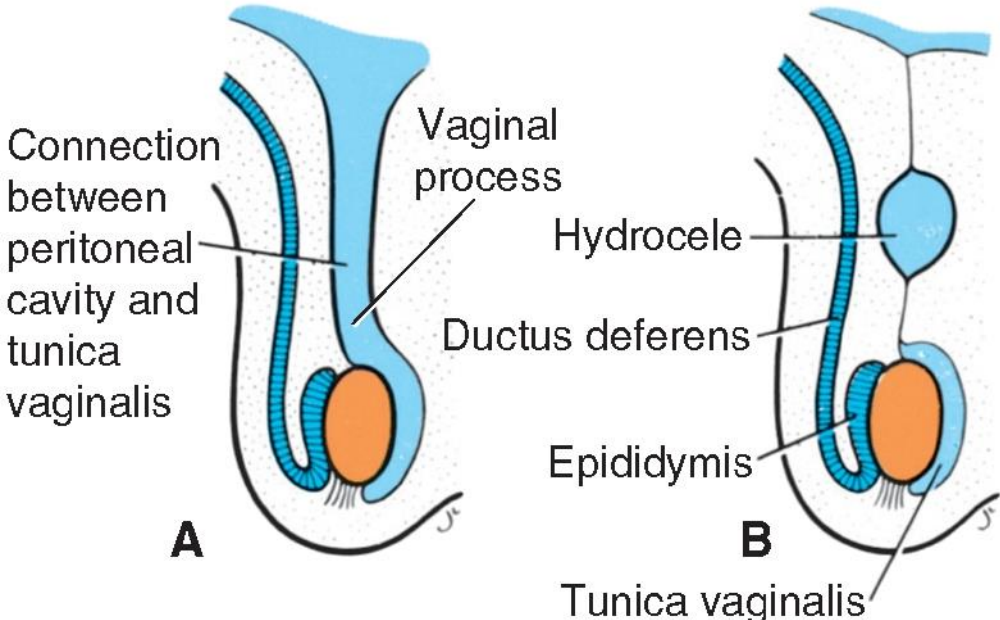
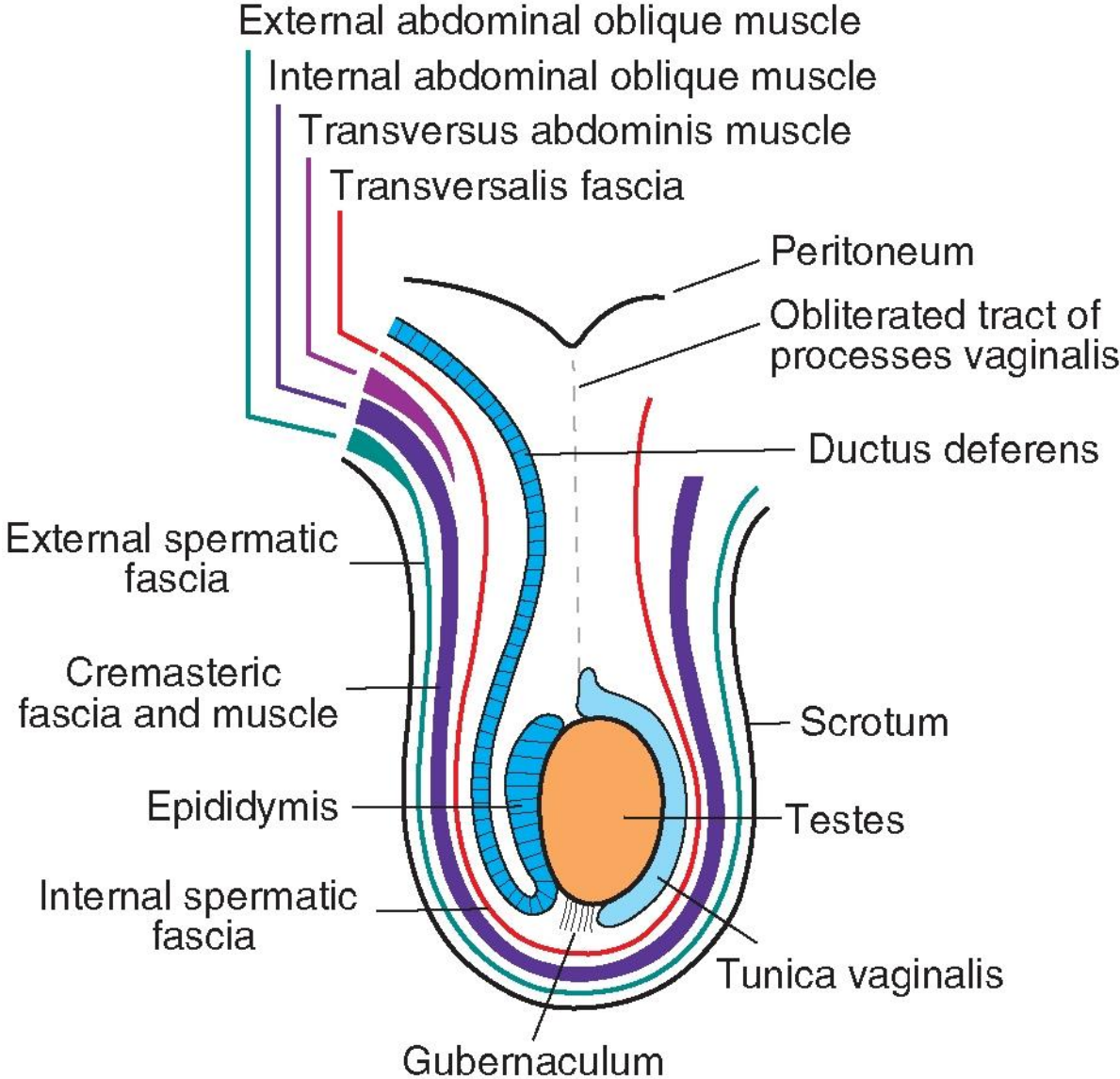
**8-9 months
(26-cm crown rump)**

F. Netter M.D.

Descent of testis



Scrotum

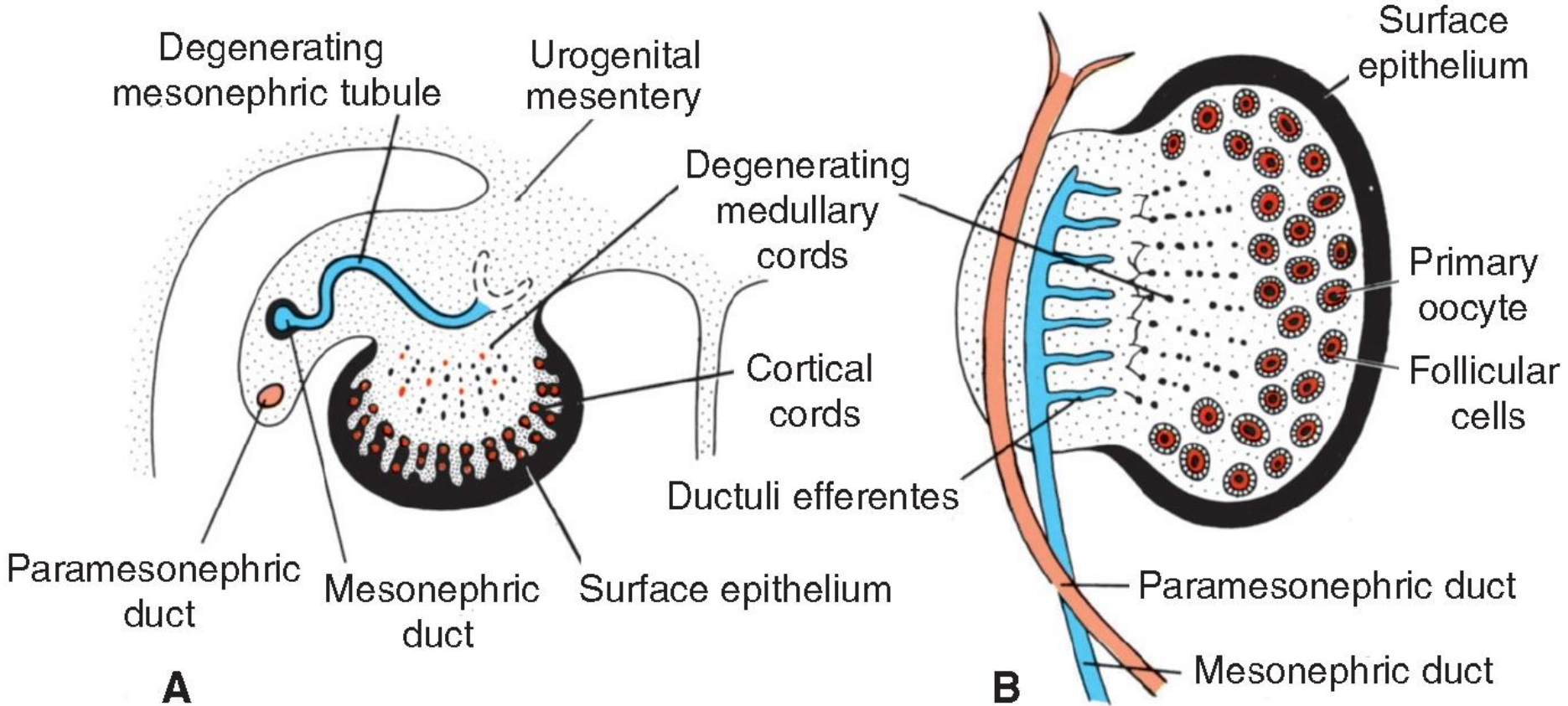


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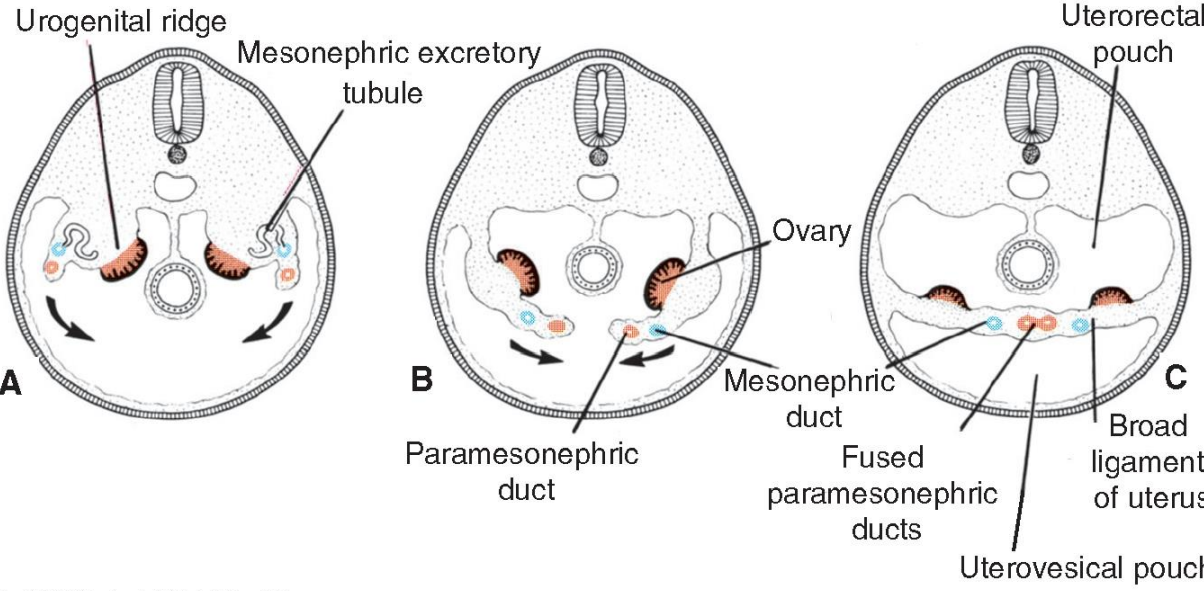
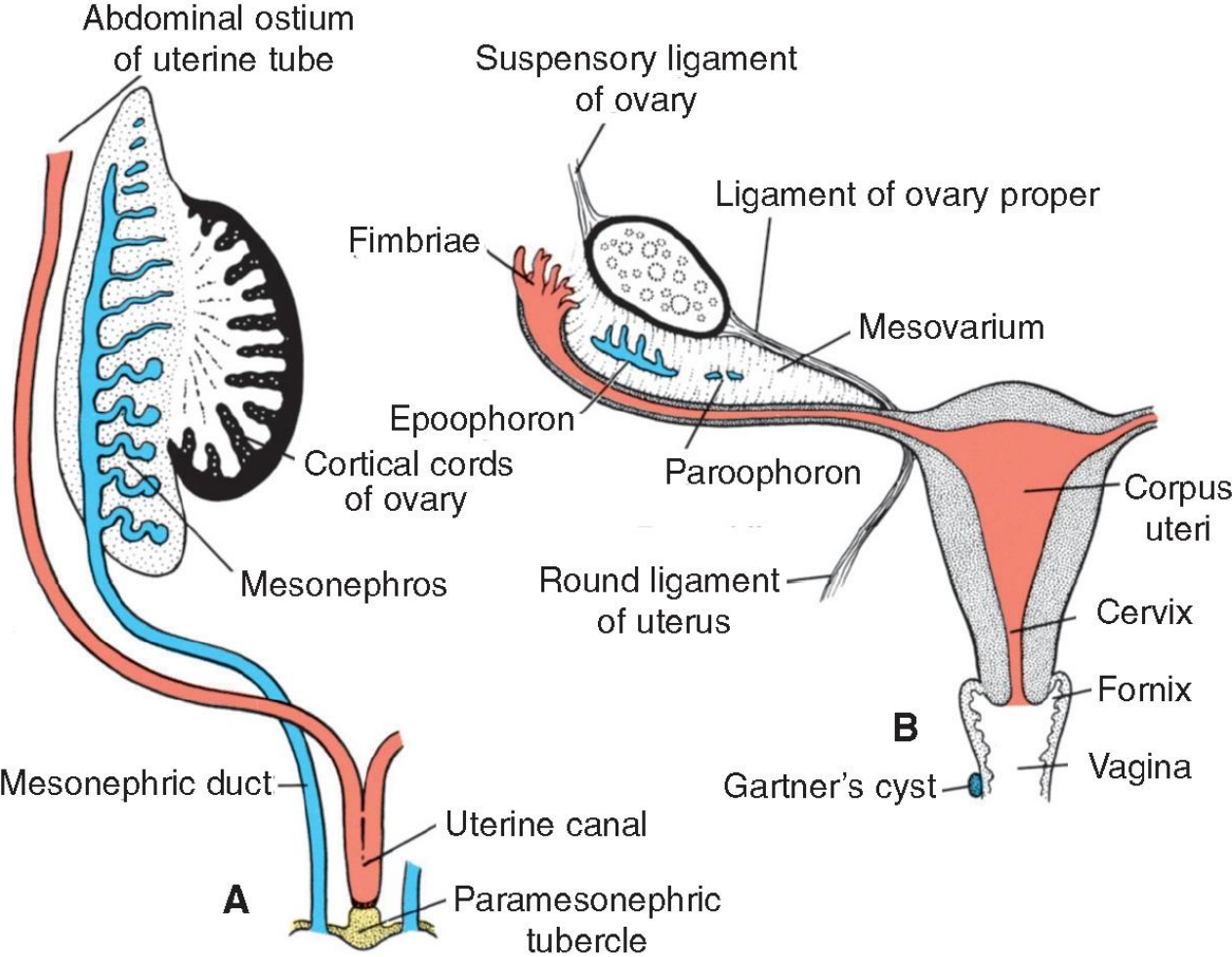
Inguinal hernia

Hydrocele

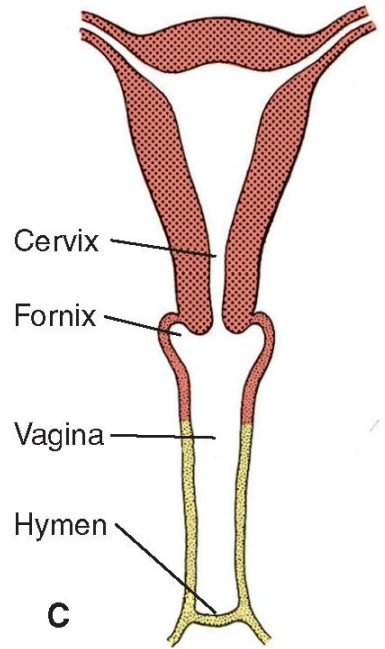
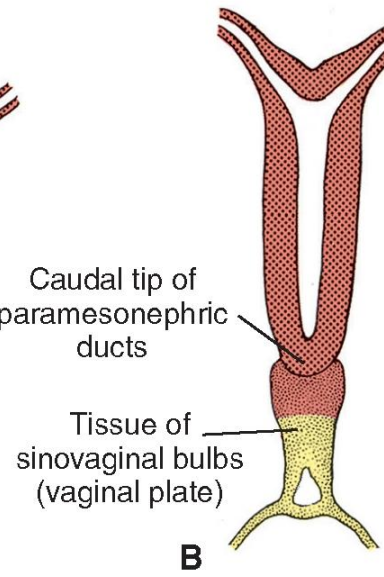
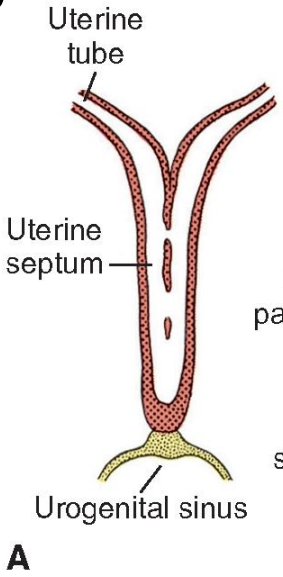
Ovary



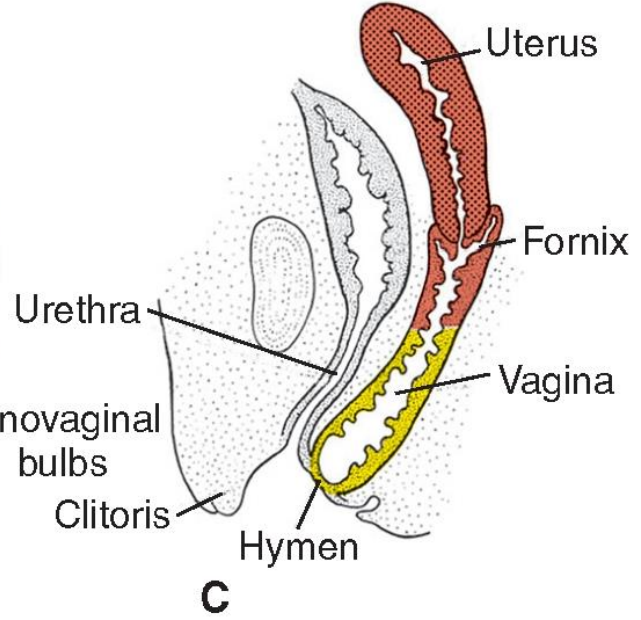
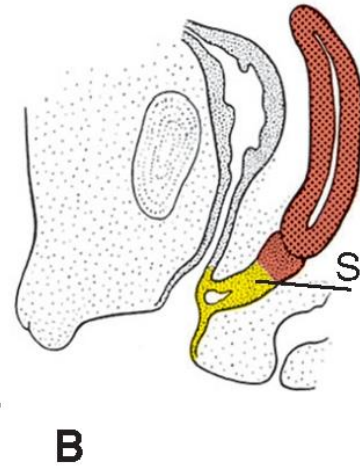
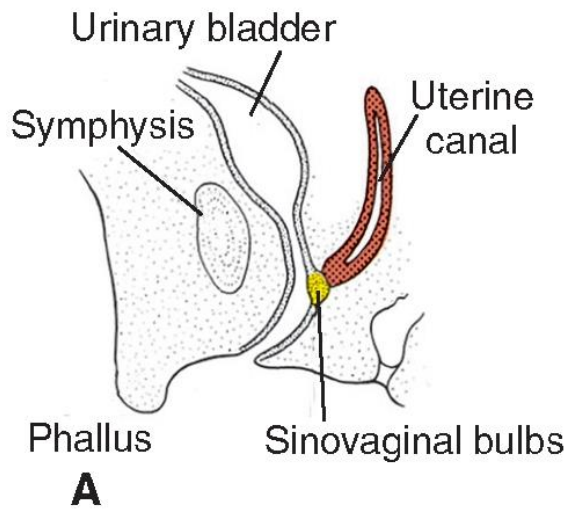
Ovary, uterine tubes, uterus, vagina



Uterus, vagina

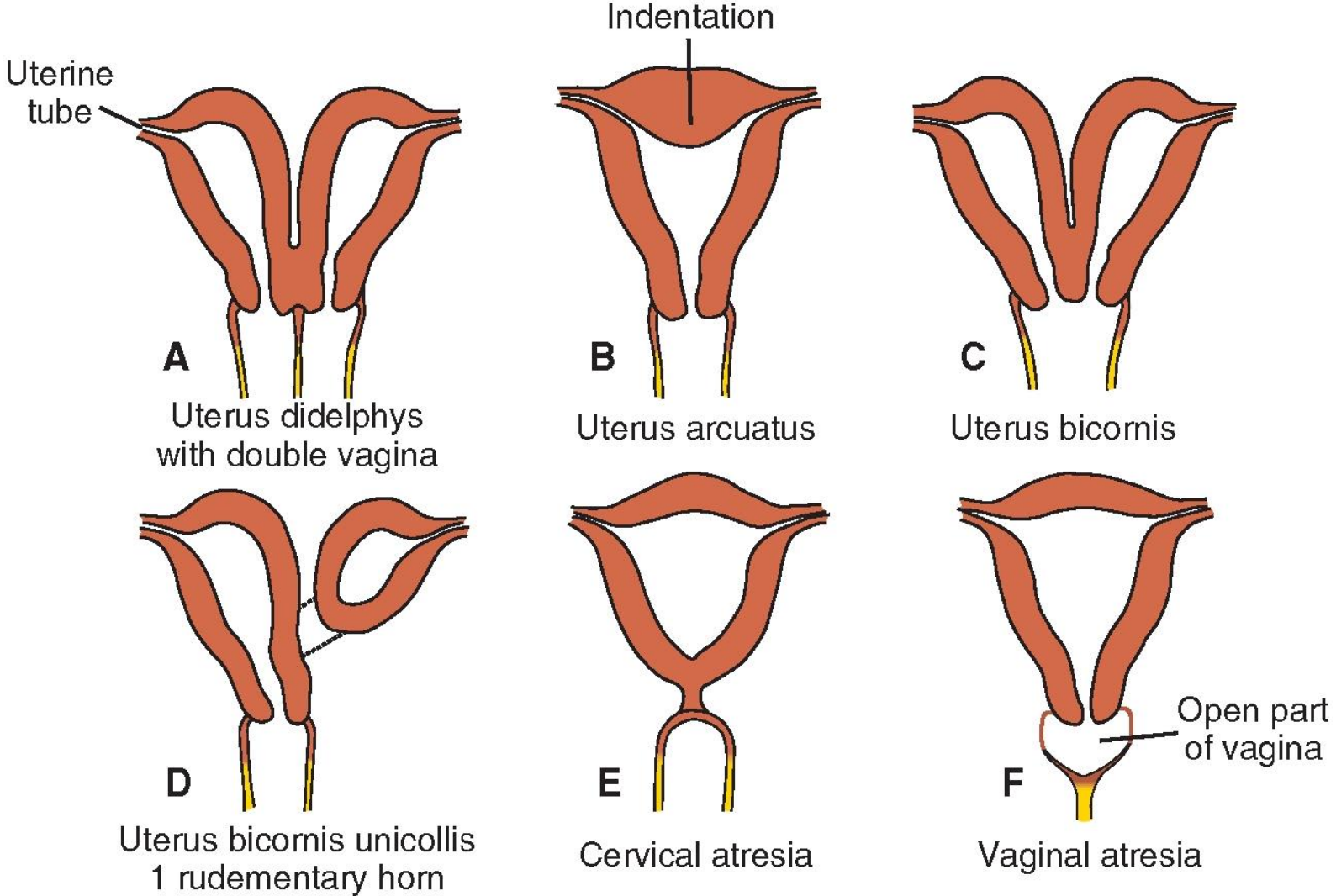


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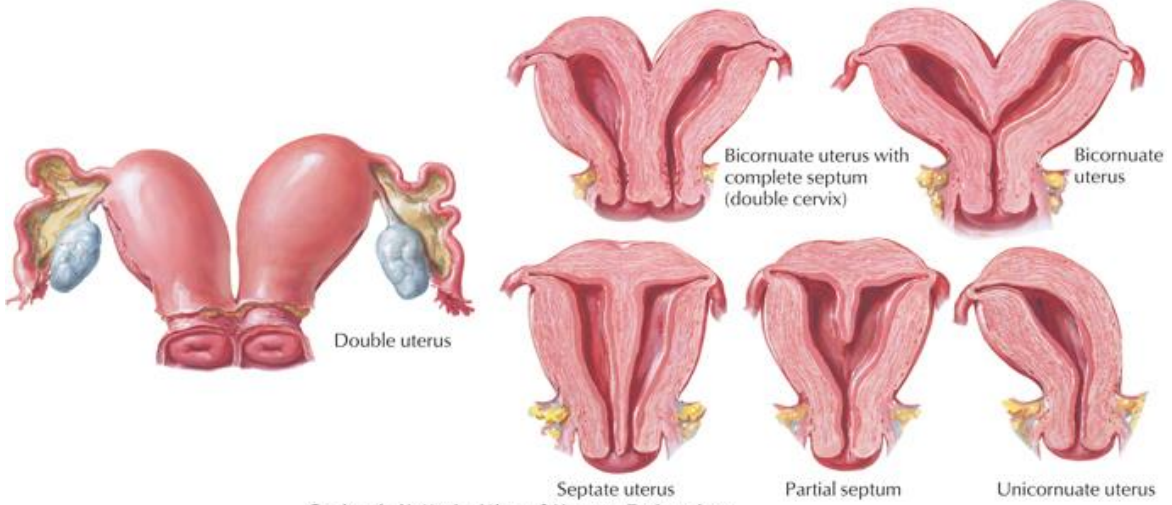
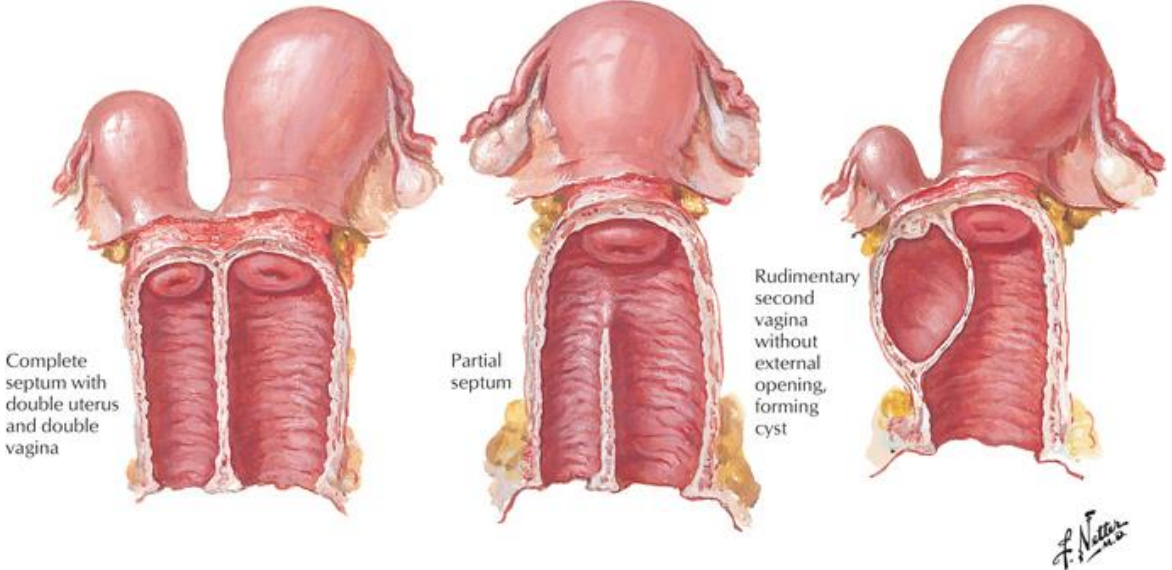


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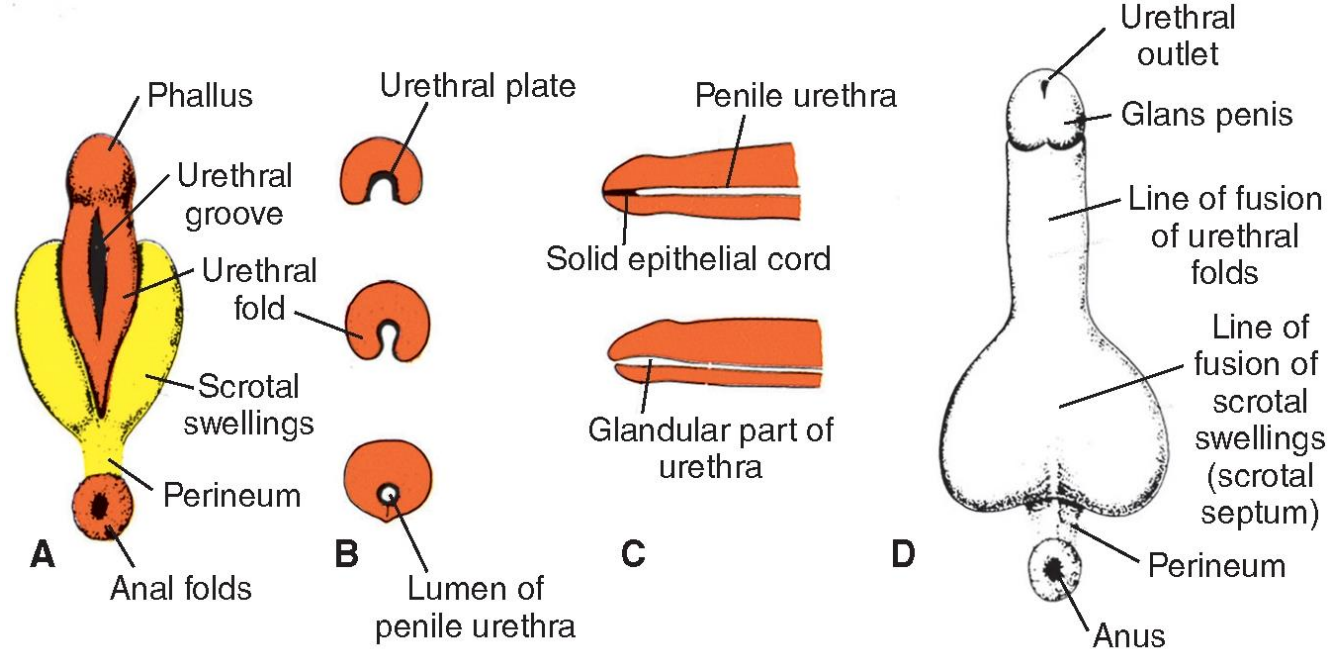
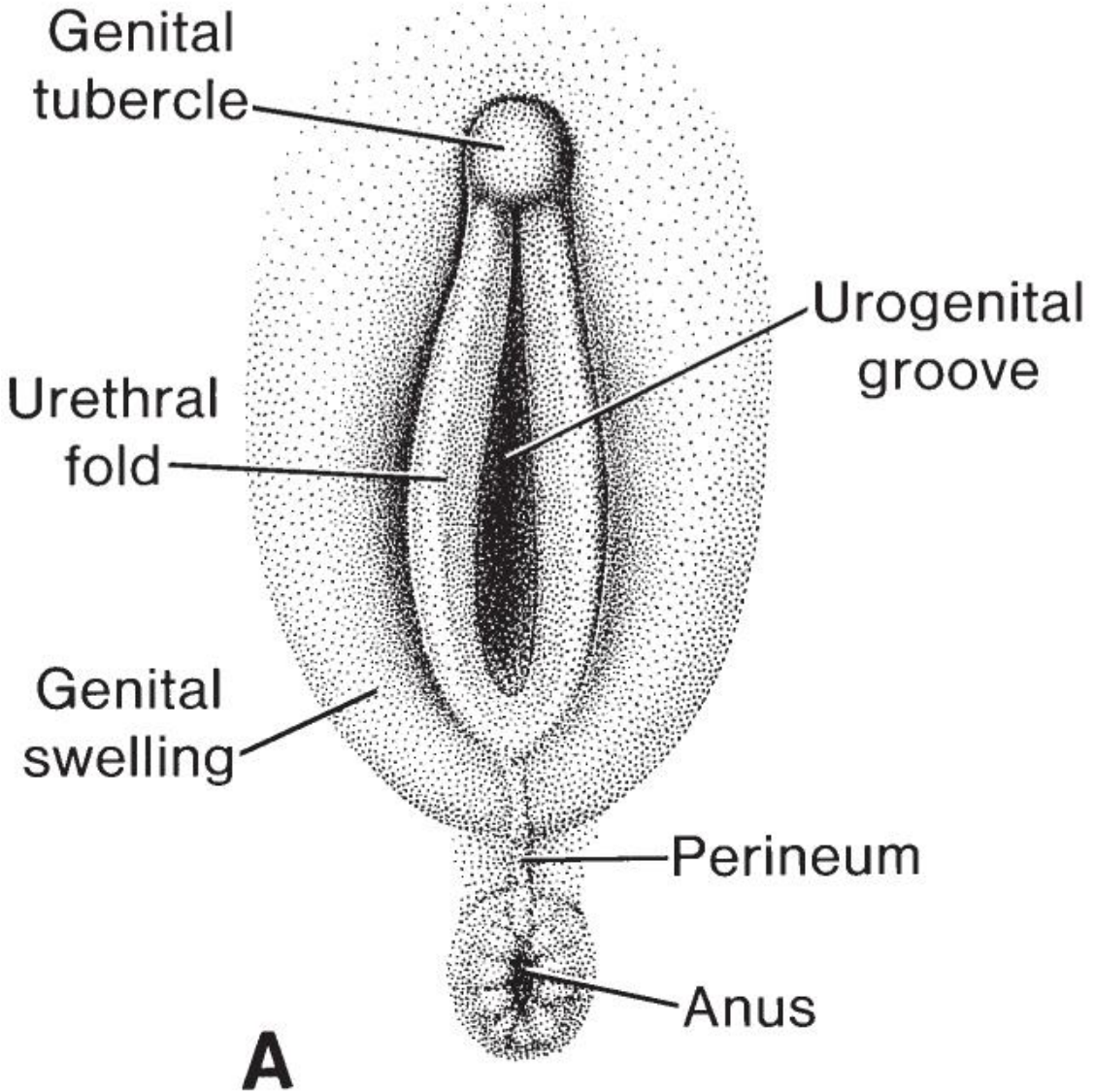
Paramesonephric duct anomalies



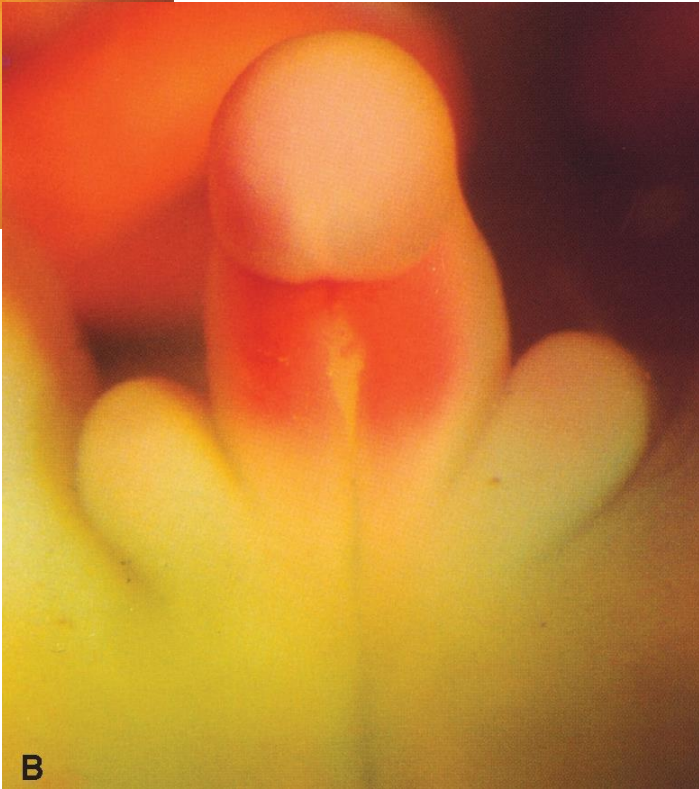
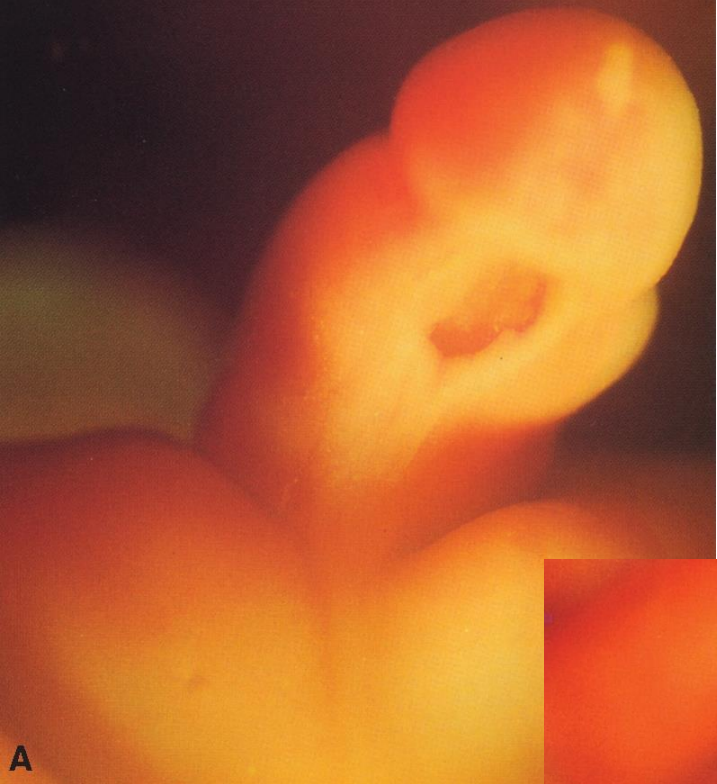
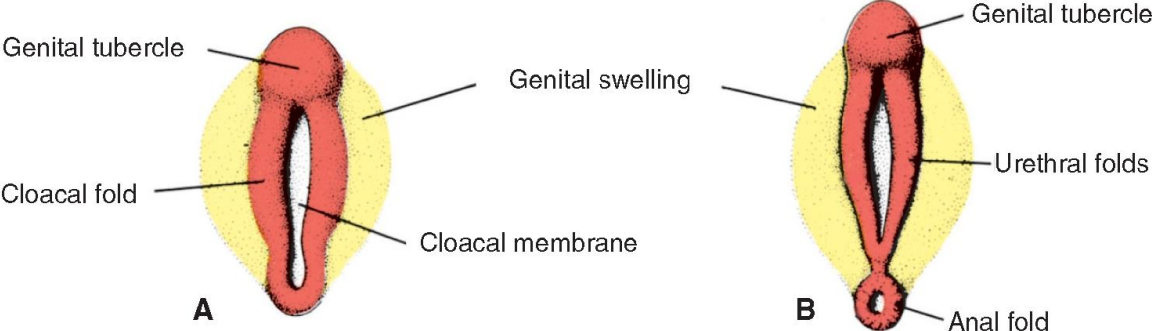
Paramesonephric duct anomalies



External genitalia

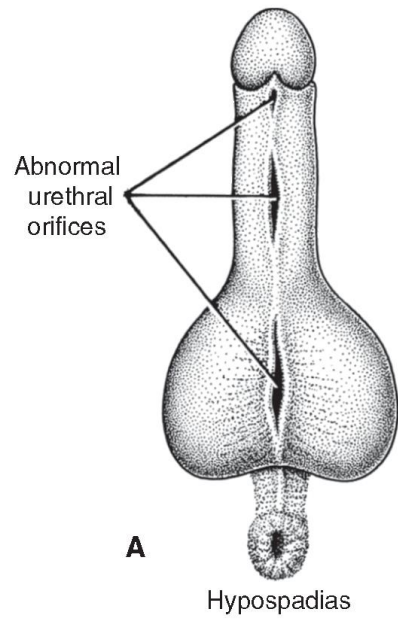
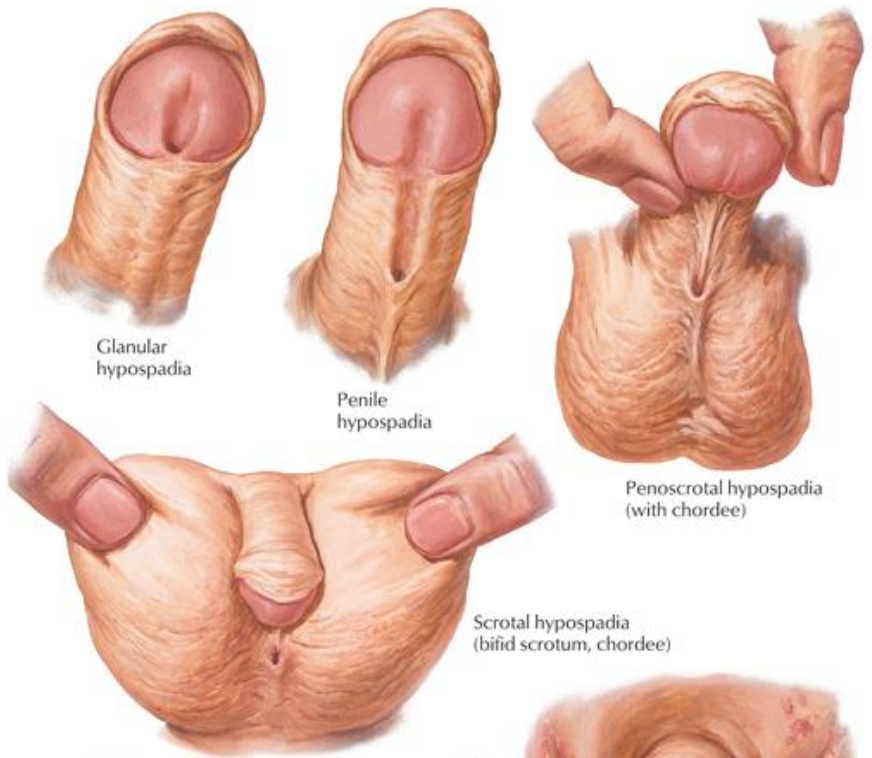


External genitalia



Defects in the male genitalia

Hypospadias



Epispadias

