

Genitourinary System

Imaging-Based Overview of Anatomy and Embryology

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9/8/11

Objectives

- Review very high-yield concepts
 - Anatomy test + USMLE Step 1
- GU Embryology
 - How it relates directly to common pathology
- Radiographic imaging
 - Brief overview of normal and abnormal findings

Overview

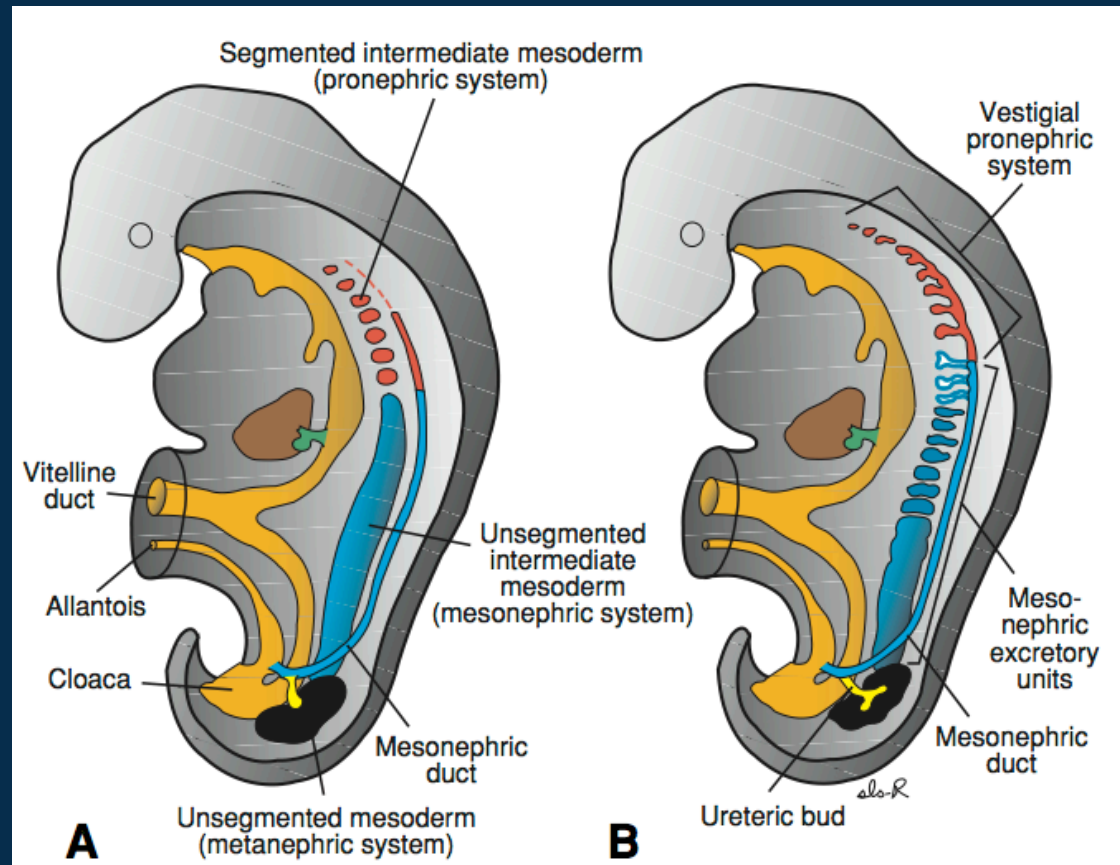
- 2 Main topics:
 - Urinary system
 - Reproductive system
- Both develop from the intermediate mesoderm
- Excretory ducts of both systems → cloaca

Part One:

URINARY SYSTEM

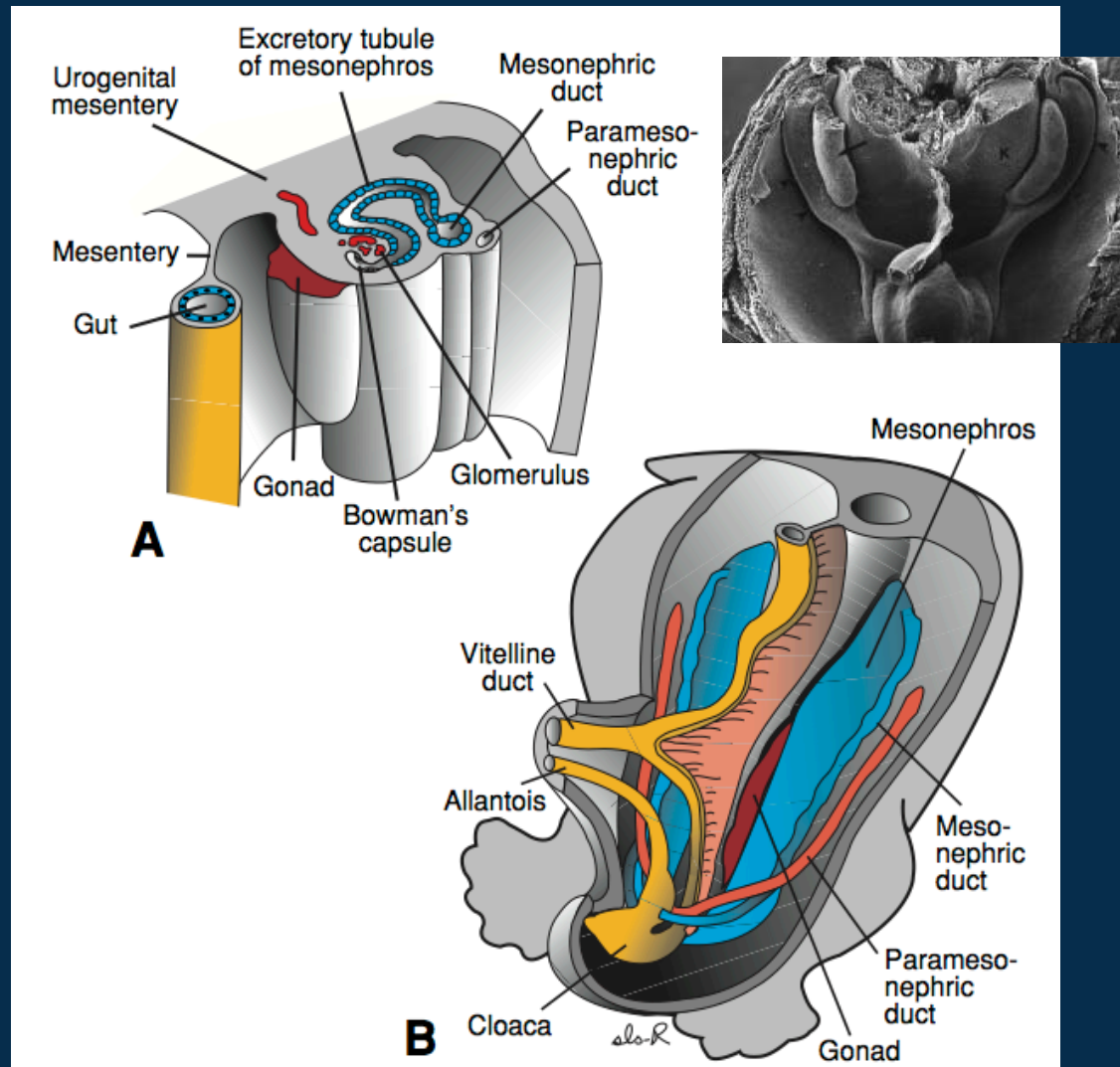
Pronephros

- 4th week
- Cranial to caudal
- **Nephrotomes**
- Forms and regresses within 1 week
- Mesonephros developing



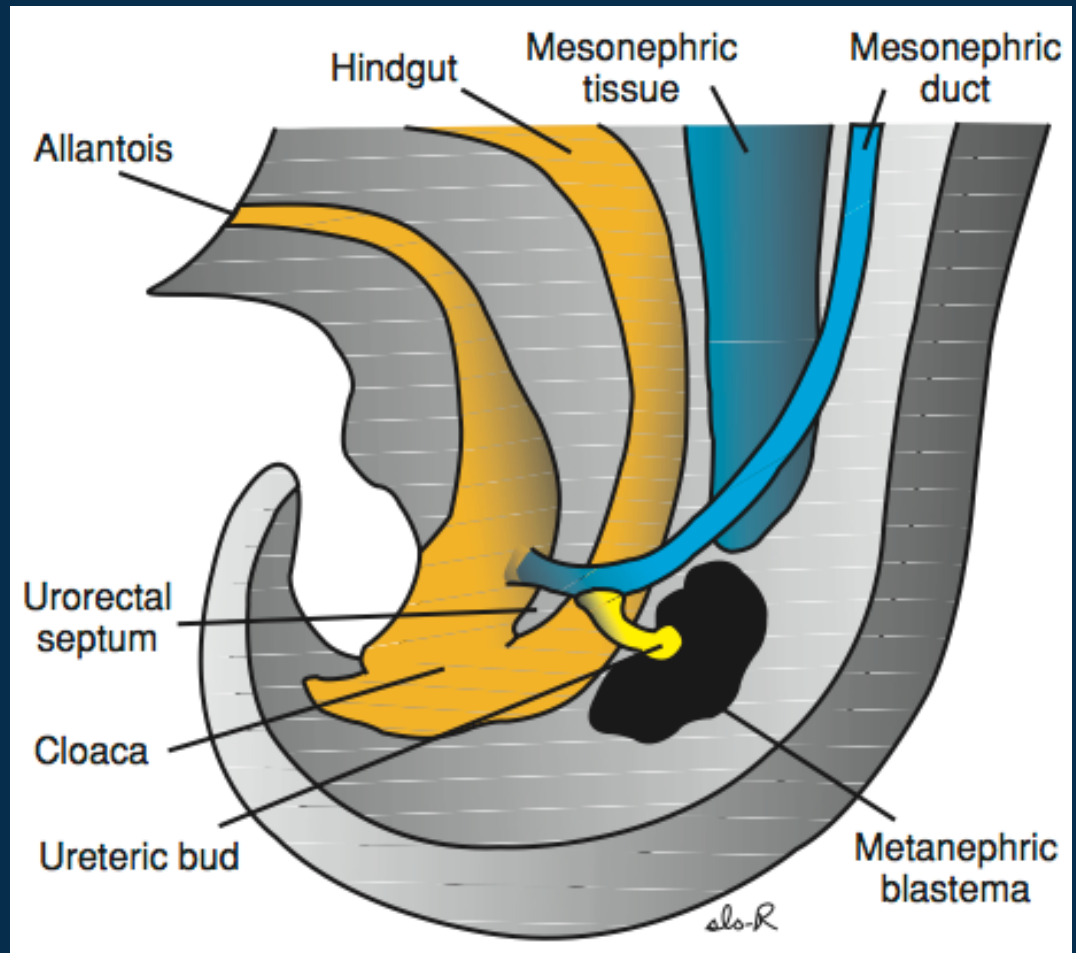
Mesonephros

- **Glomerulus** at medial end
- **Bowman's capsule** around glomerulus
- **Mesonephric duct** laterally
- **Urogenital ridge**
- **Gonadal ridge**
- Disappears by 2nd month in females
- Partially remains in males to form genital system



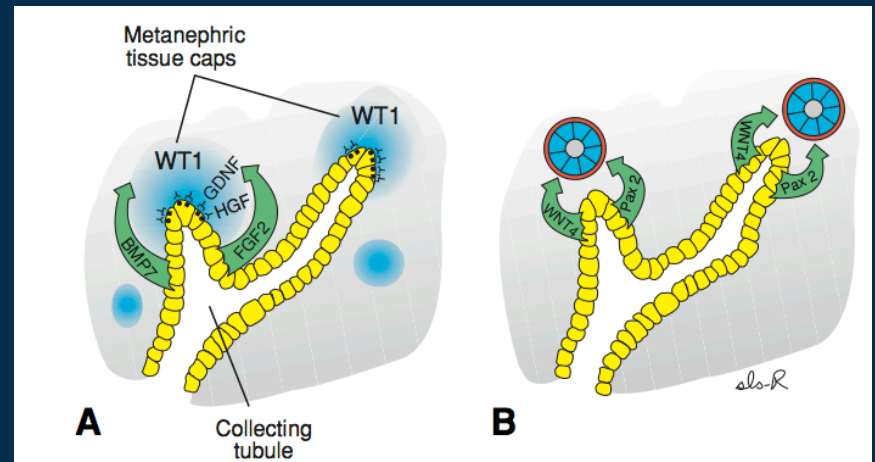
Metanephros

- Permanent kidney
- 5th week
- **Metanephros** = Glomerulus to distal convoluted tubule
- **Ureteric bud** = collecting ducts, major/minor calyces, renal pelvis, and ureter

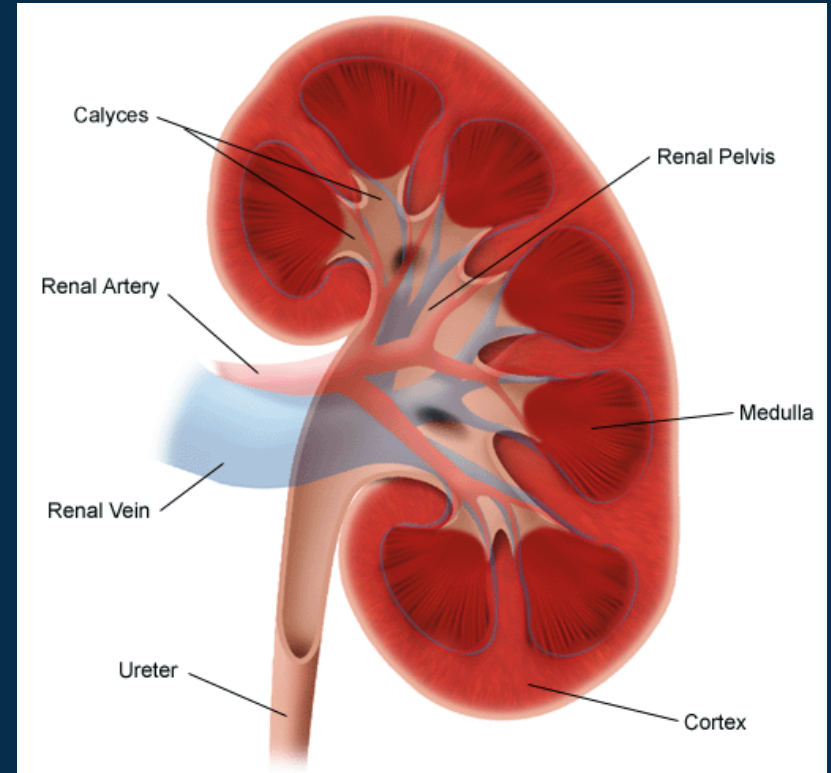
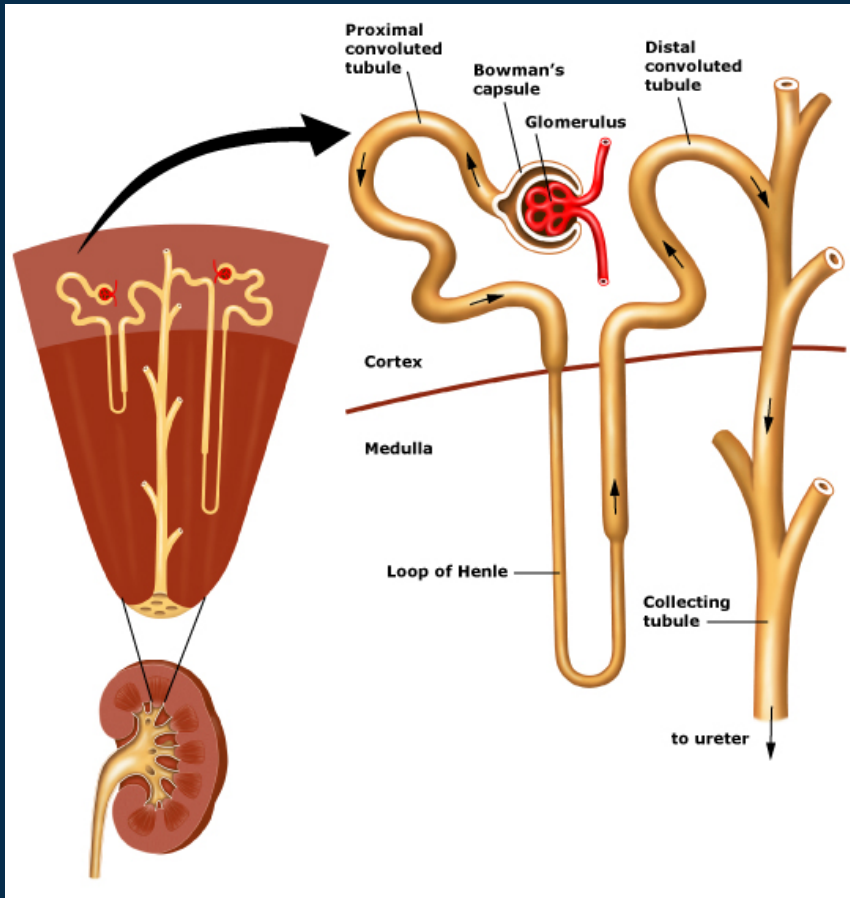


Molecular Regulation

- **Epithelial-Mesenchymal interactions**
 - Epithelium of the ureteric bud from the mesonephros interacts with the mesenchyme of the metanephric blastema
- Complex **two-way signaling** process of reciprocal induction.

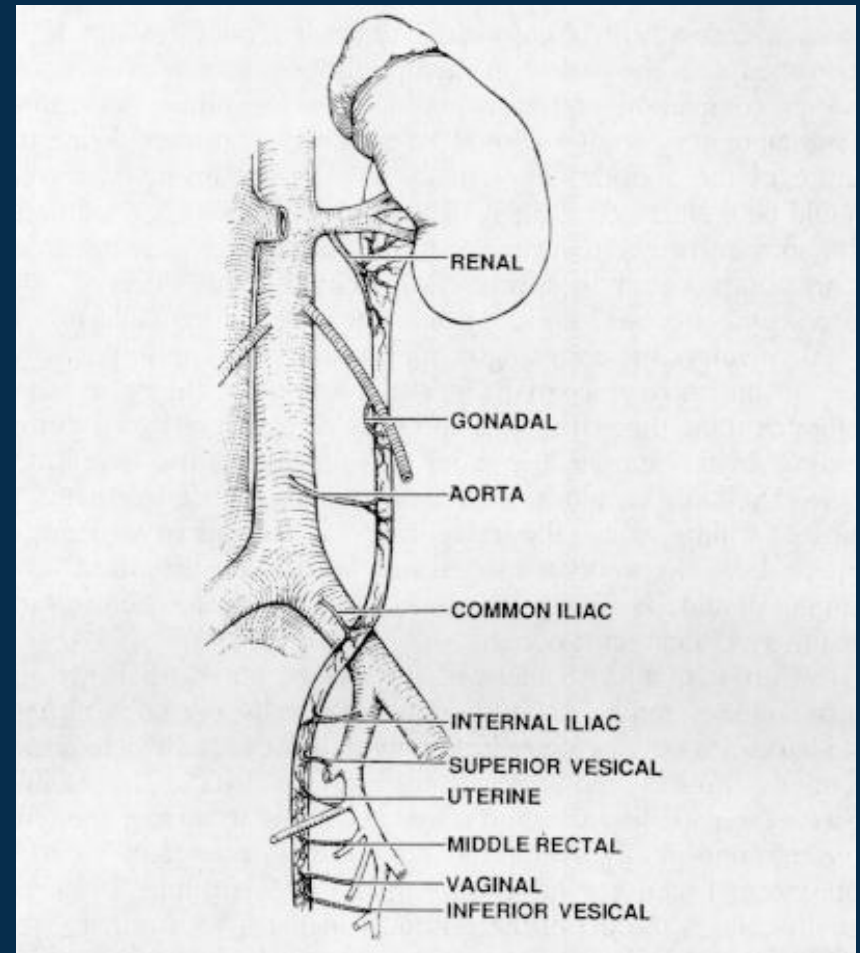


Renal Anatomy



Ureters

- Retroperitoneal
- Crosses posteriorly to gonadal vessels
- Crosses bifurcation of the common iliac art.
- **Obstruction points:**
 - Ureteropelvic jnct.
 - Pelvic brim over distal end of common iliac
 - Ureterovesicular jnct.



Kidney-Ureter-Bladder (KUB)



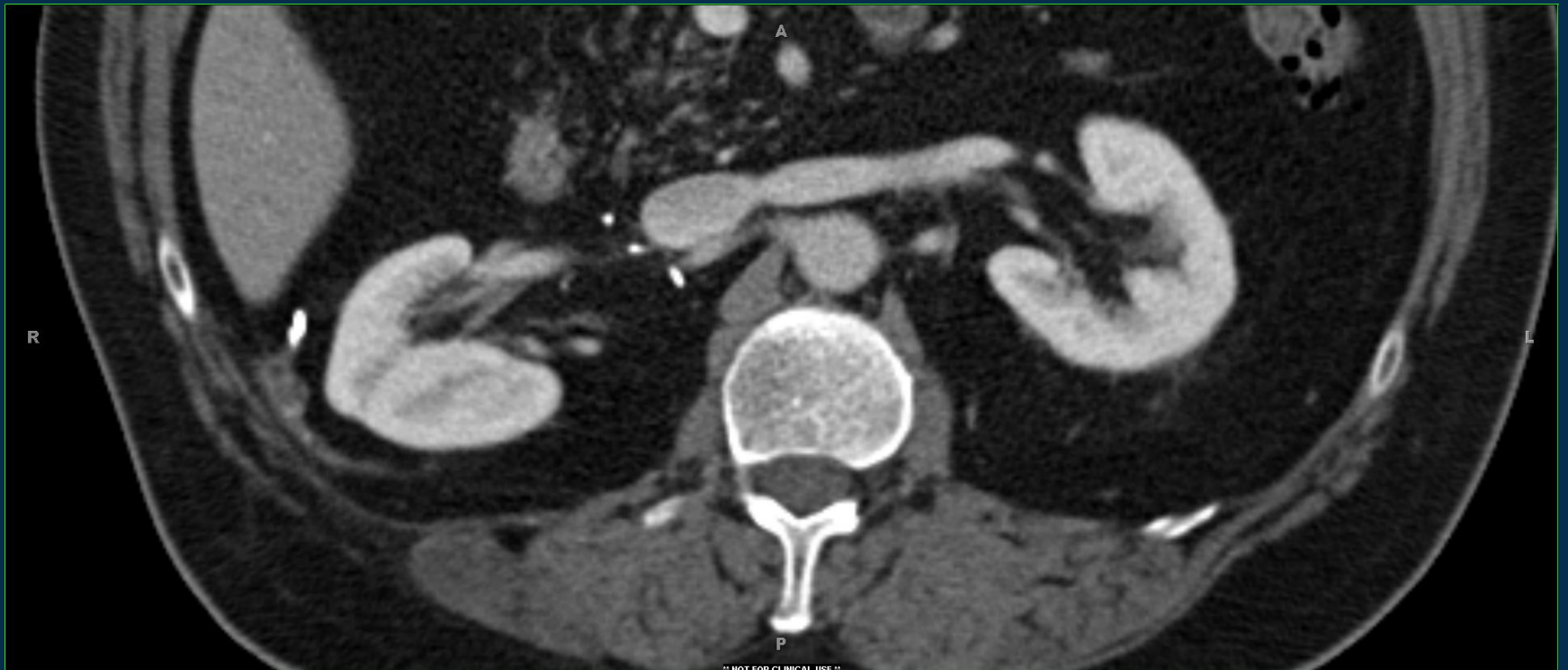
CT Urogram: Non-contrast



CT Urogram: Corticomedullary Phase



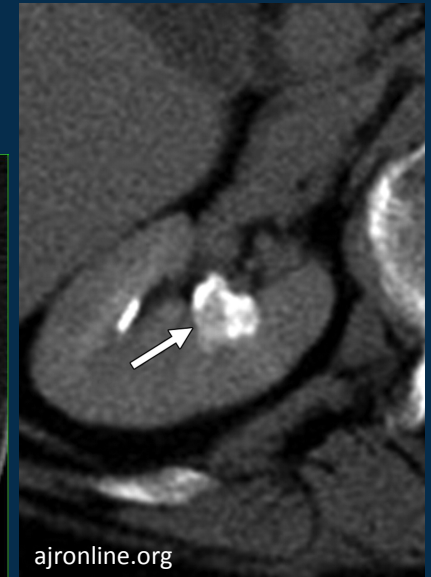
CT Urogram: Nephrographic Phase



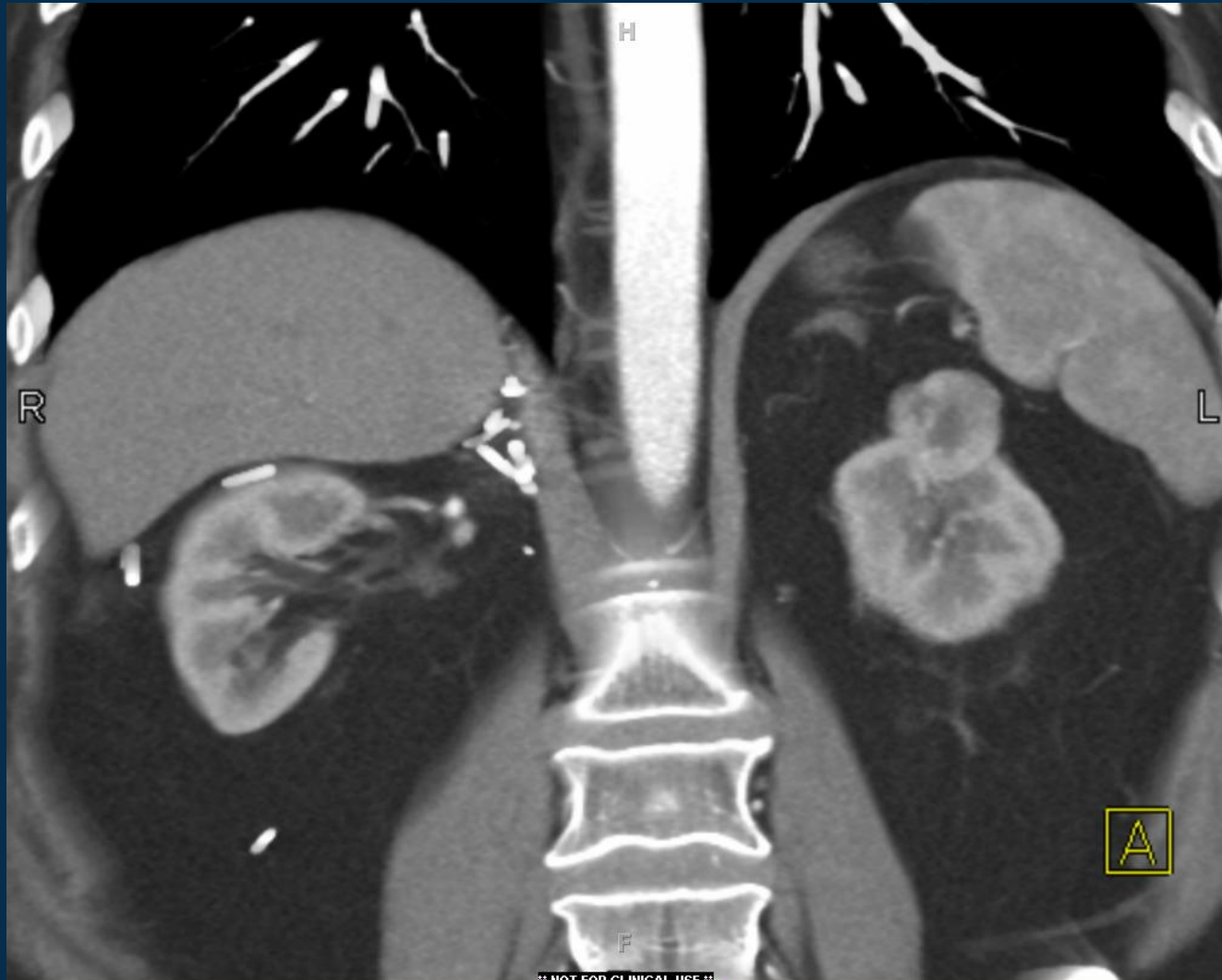
CT Urogram: Excretory Phase



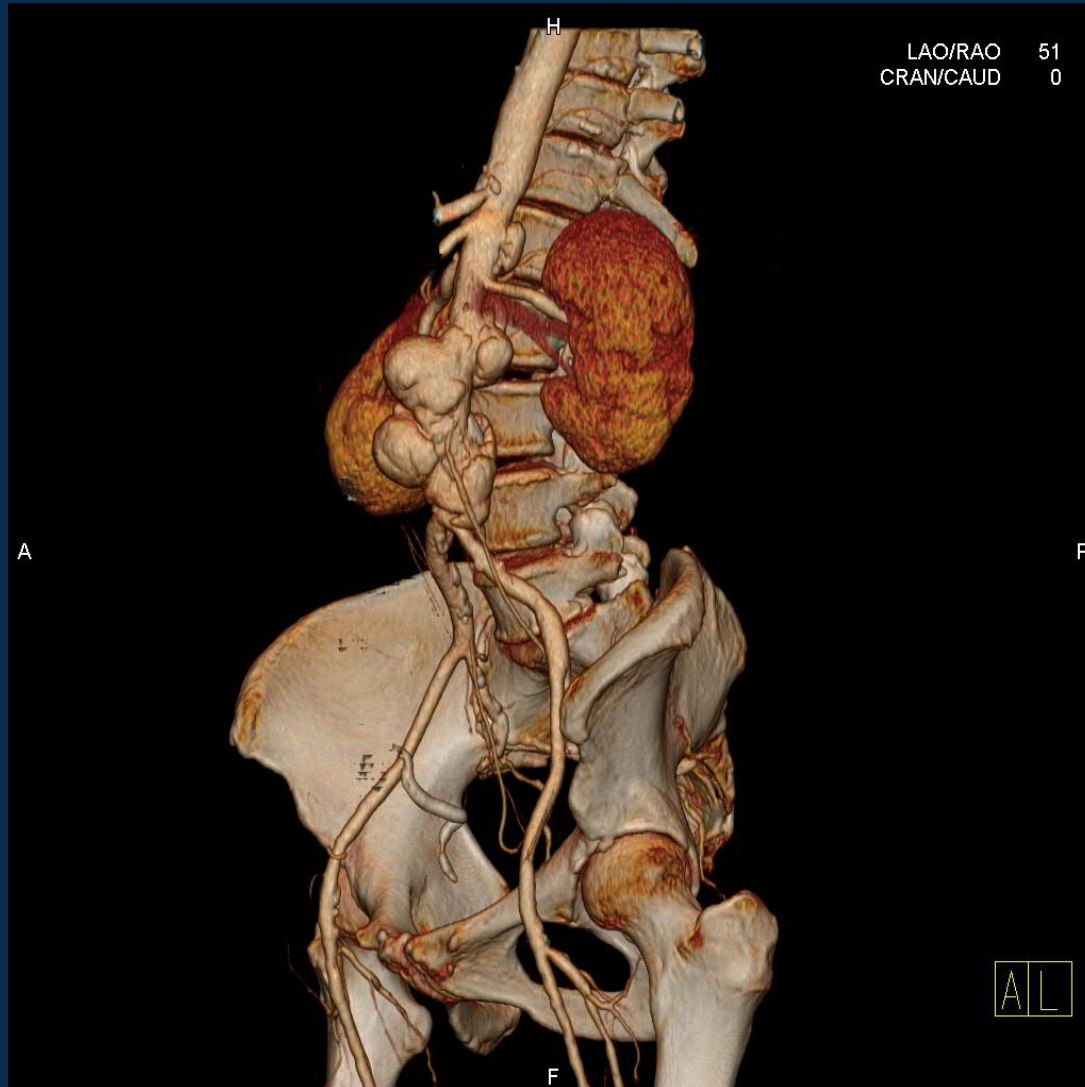
CT Urogram: Excretory Phase



MPR and 3D Reconstructions



MPR and 3D Reconstructions



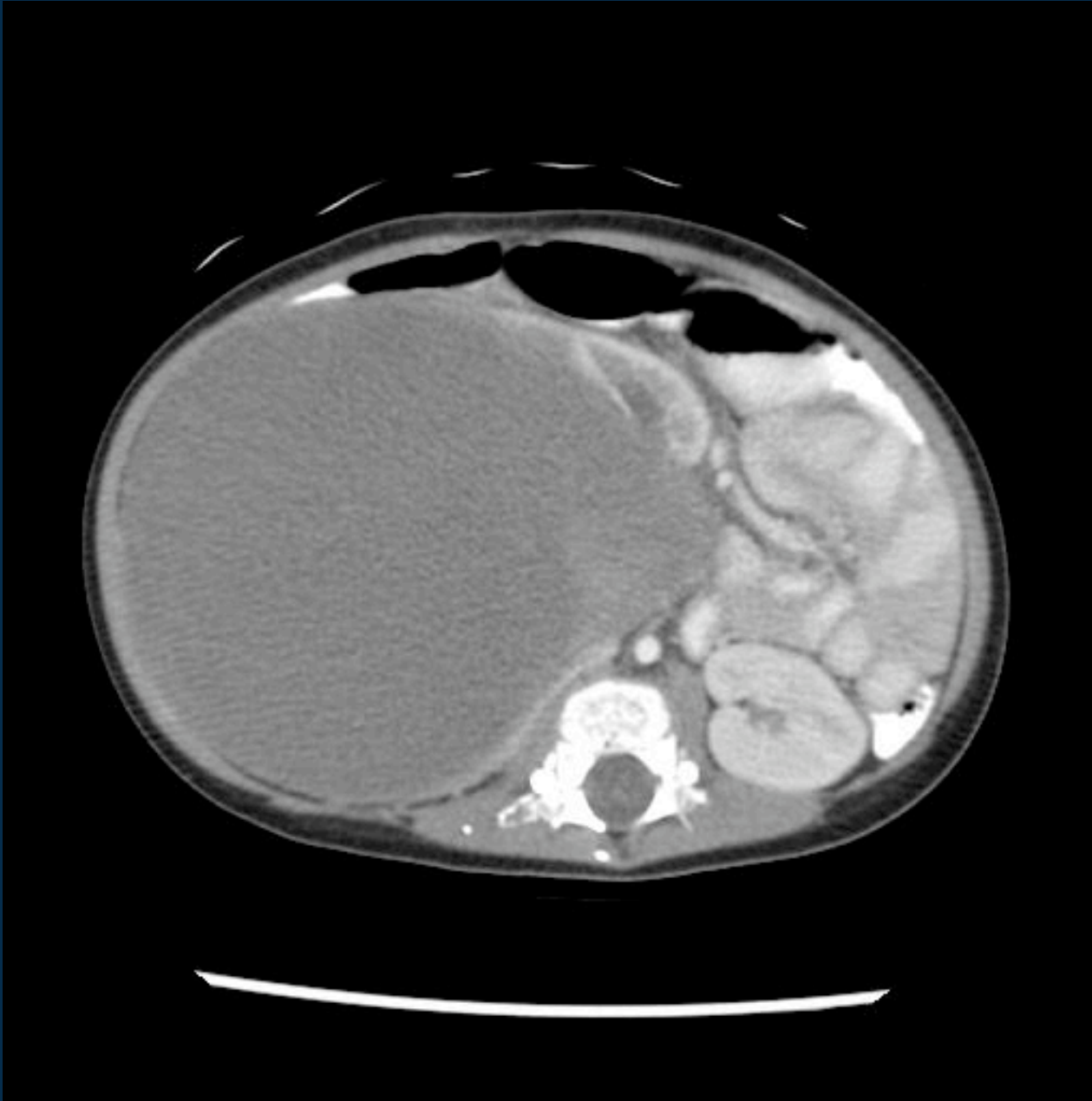
CT Angiogram



Renal Ultrasound

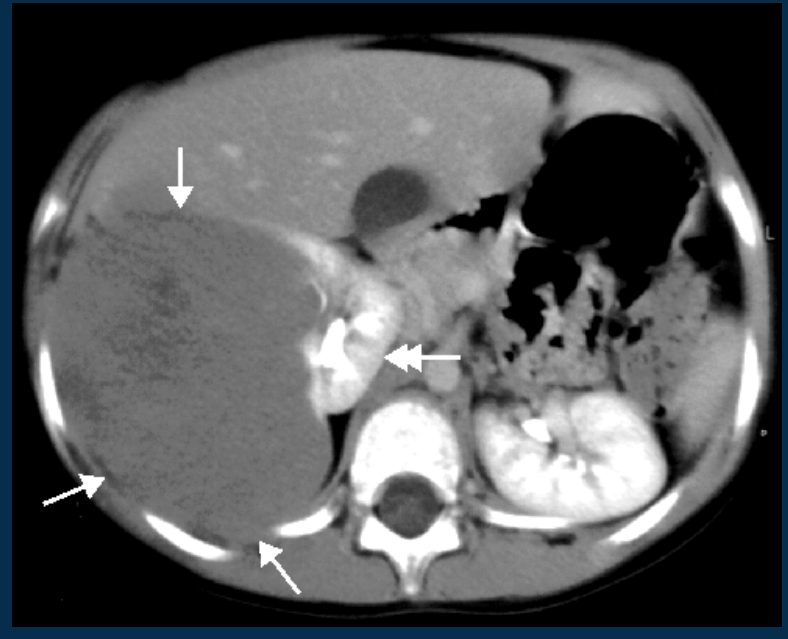


What's Abnormal?



Wilms Tumor

- Typically in children
- Mutation in **WT1** gene on chromosome **11**
- Defect in **reciprocal induction system**
- **WAGR** syndrome:
 - Aniridia
 - Hemihypertrophy
 - Wilm's tumor

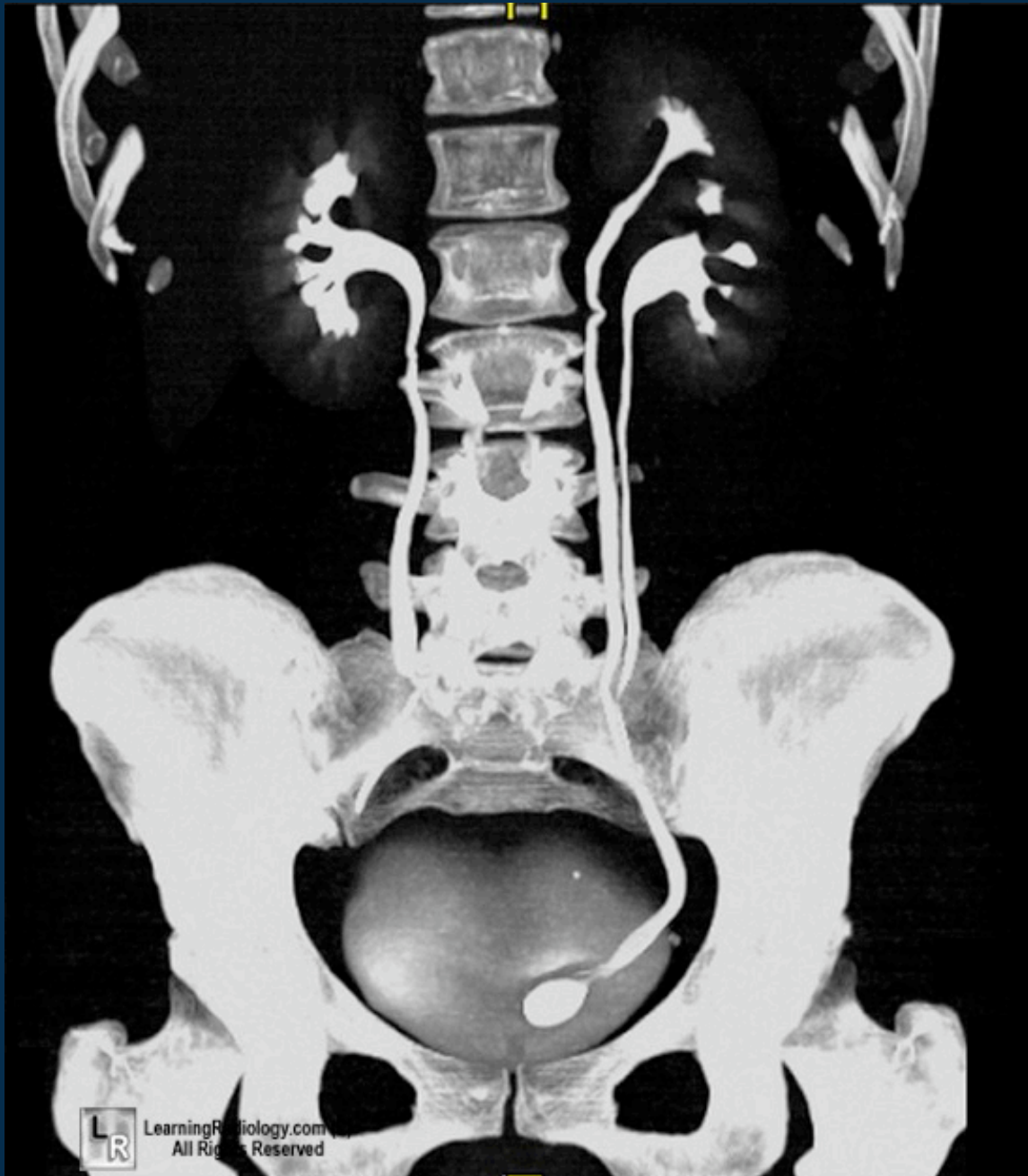


Potter's Sequence

- Malformation of the **ureteric bud**
- Bilateral renal agenesis
- **Oligohydramnios**
- Limb deformities
- Facial deformities
- Pulmonary hypoplasia

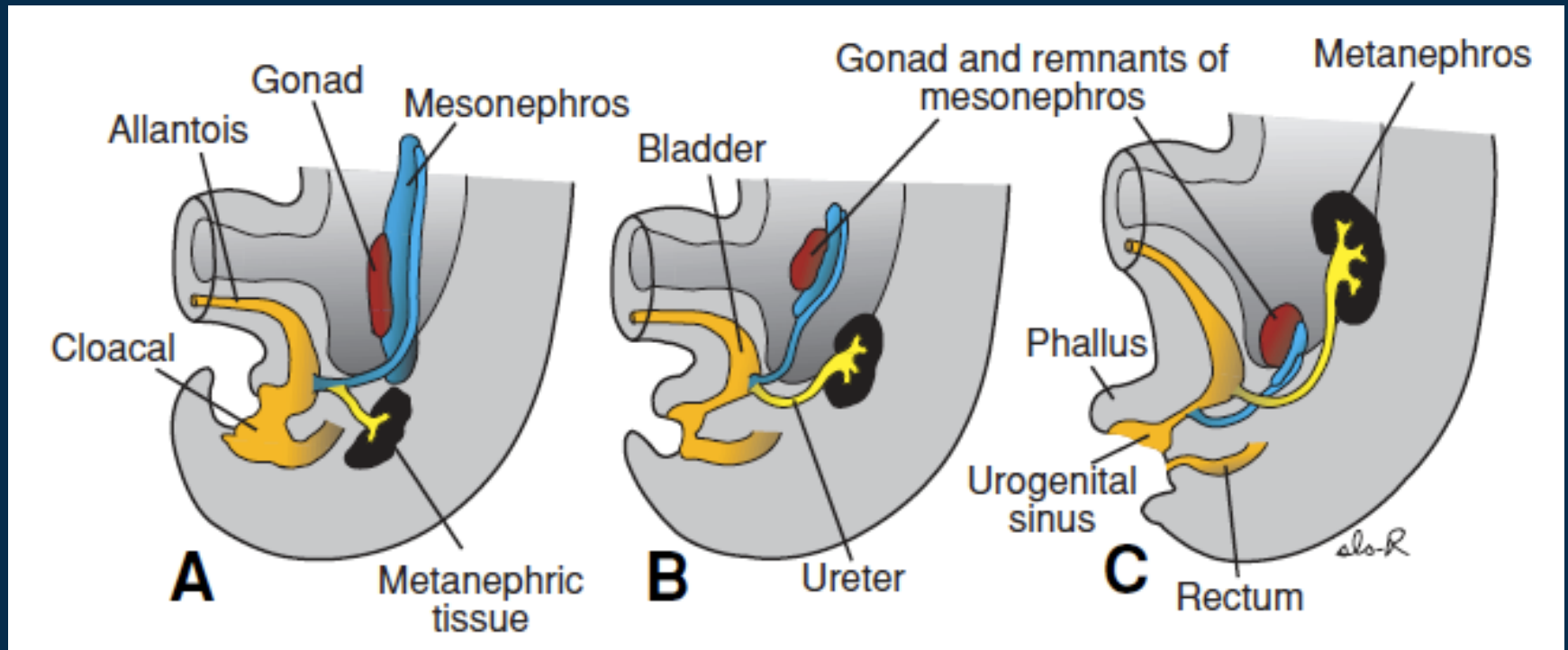


What's Abnormal?



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Position of Kidney





What's Abnormal?



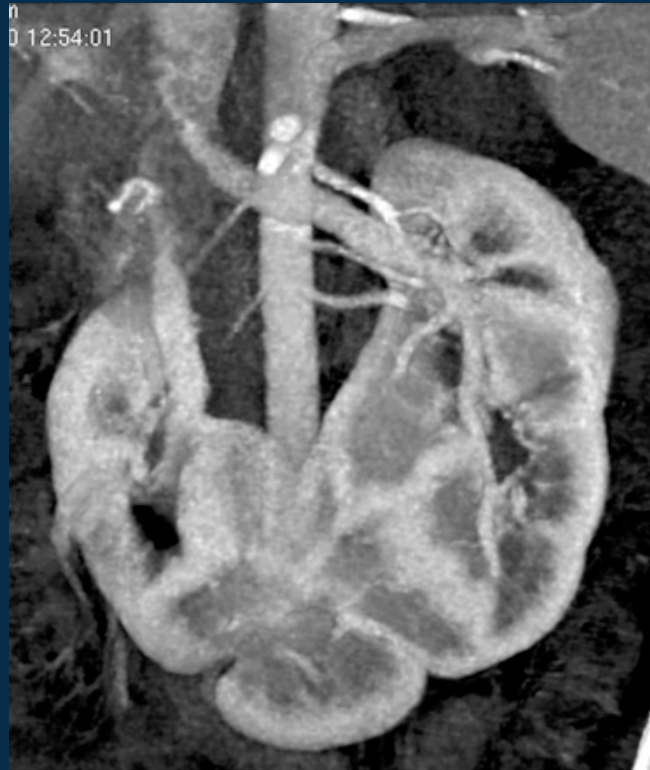
Braveheart, Paramount Pictures, 20th Century Fox

What's Abnormal?



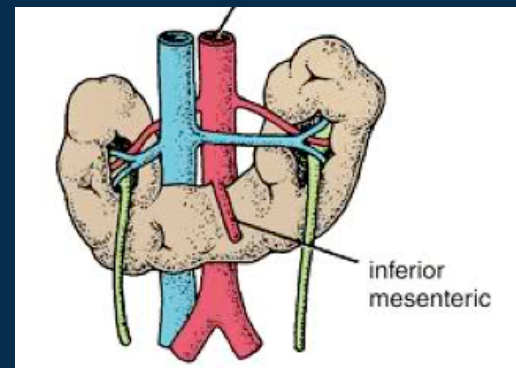
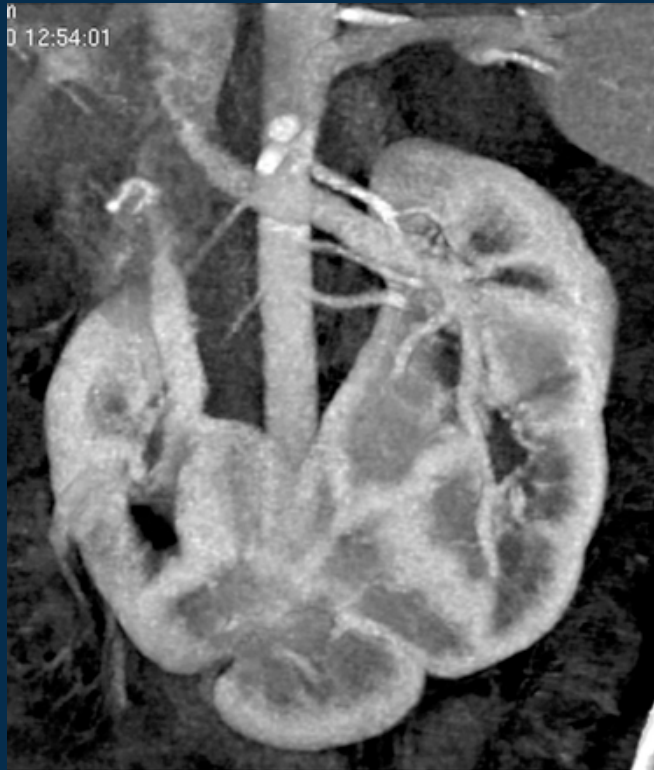
** NOT FOR CLINICAL USE **

Horseshoe Kidney

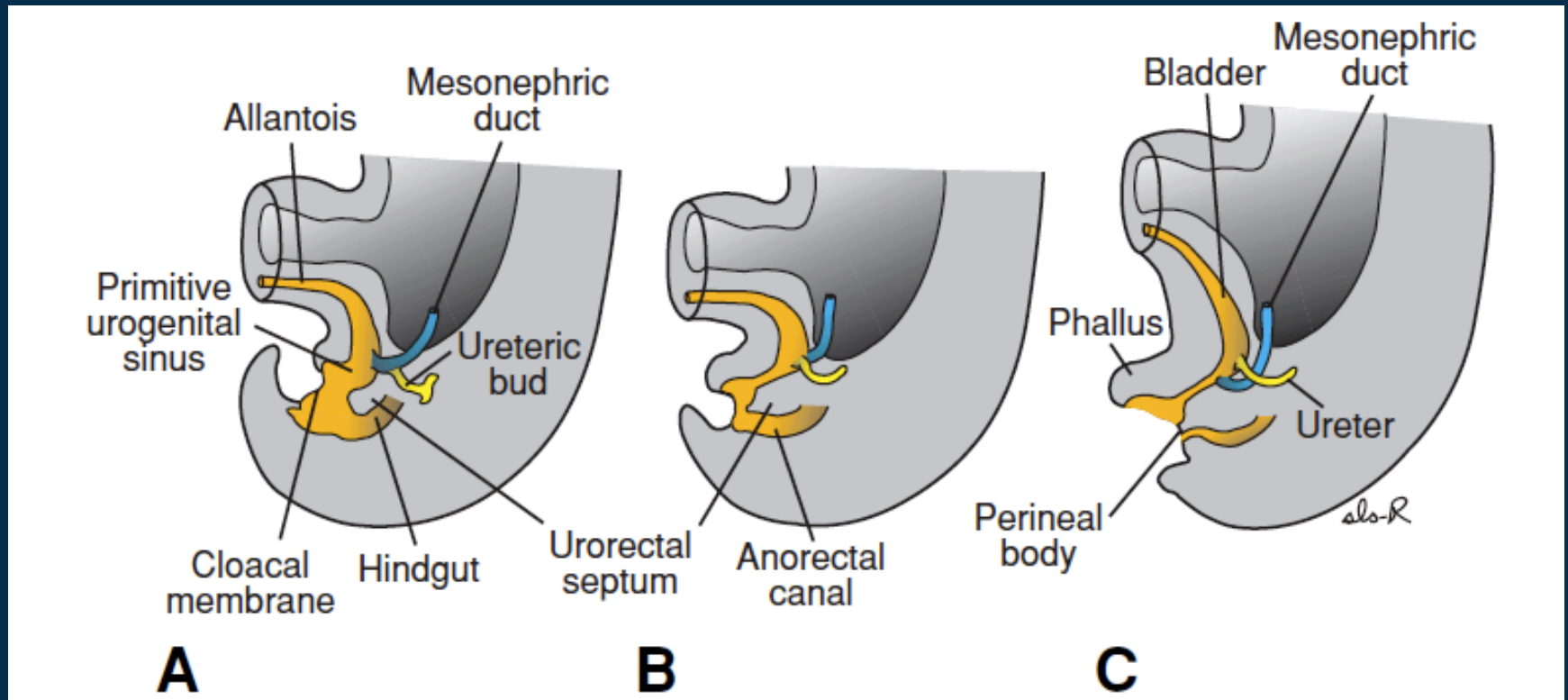


Which vascular structure would prevent its ascent into the abdomen?

Horseshoe Kidney



Division of the Cloaca



A

B

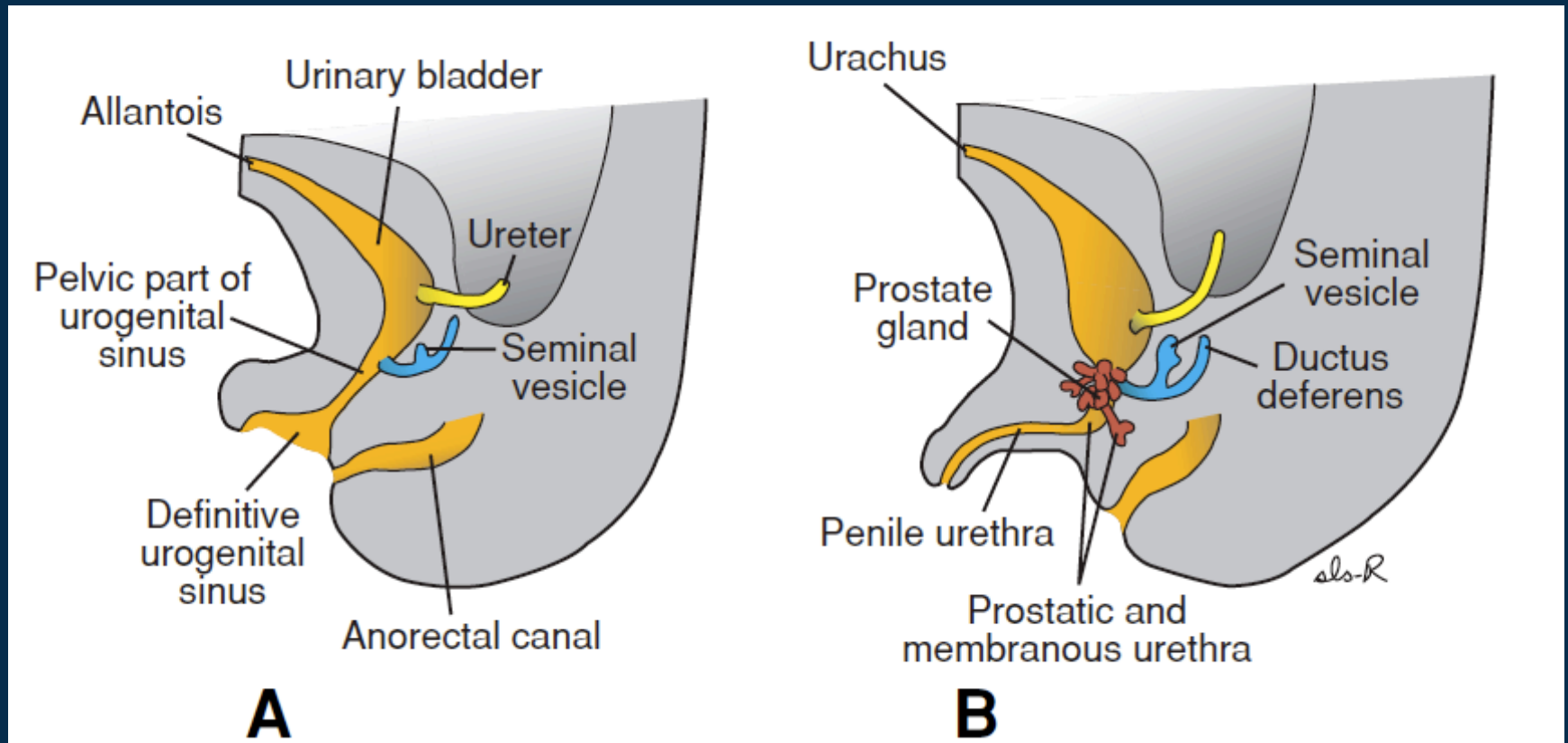
C

5th Week

7th Week

8th Week

Urogenital Sinus

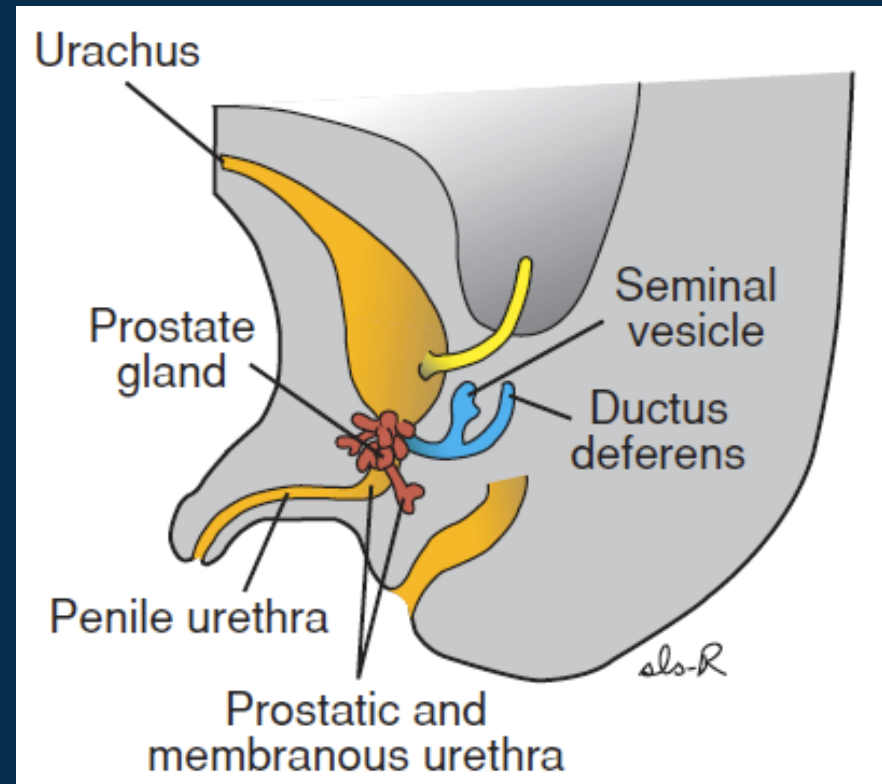


A
Undifferentiated

B
Male

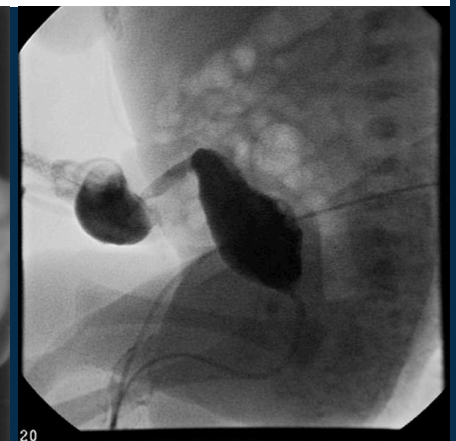
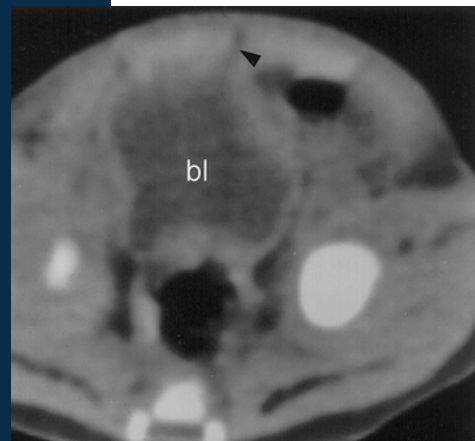
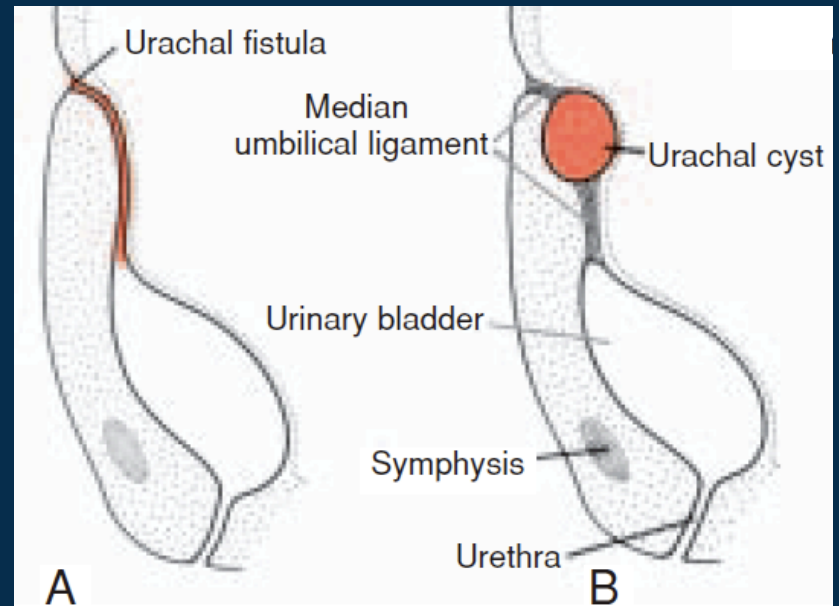
Urethra

- Urethral epithelium from **endoderm**
- Everything else is splanchnic **mesoderm**
- Proliferation of the **prostatic urethra** in 3rd month
 - Male**: prostate gland
 - Female**: urethral and paraurethral glands

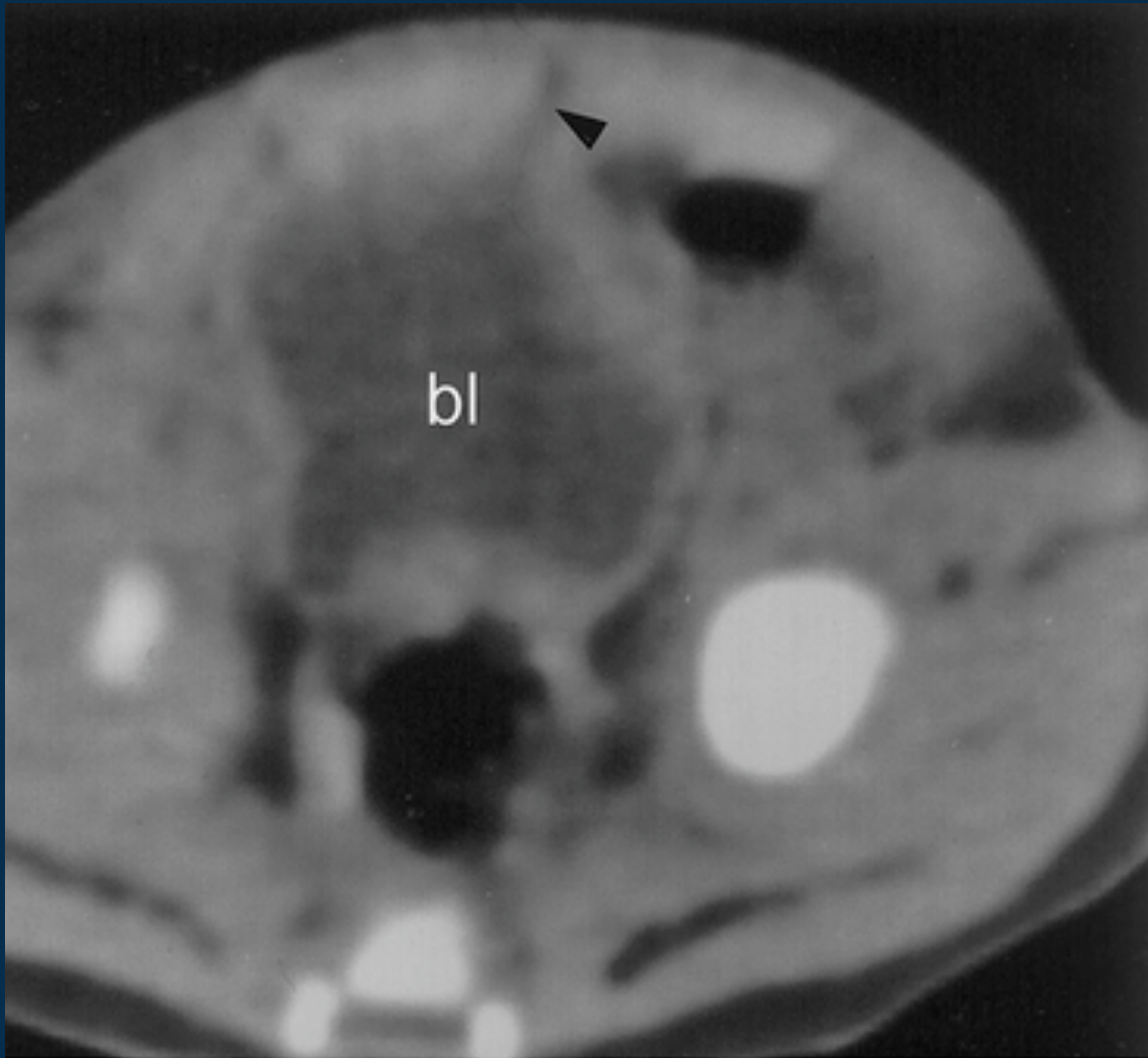


Bladder Defects

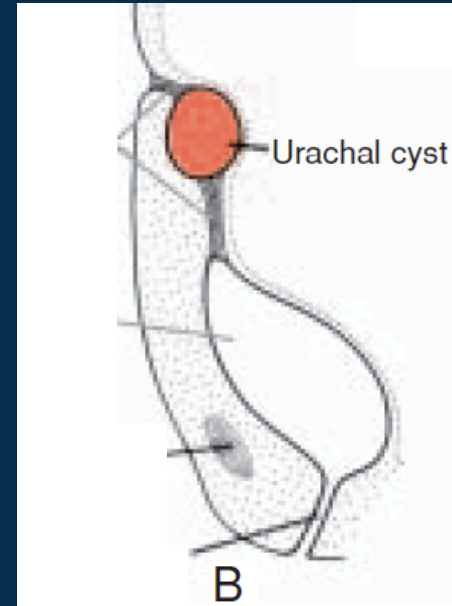
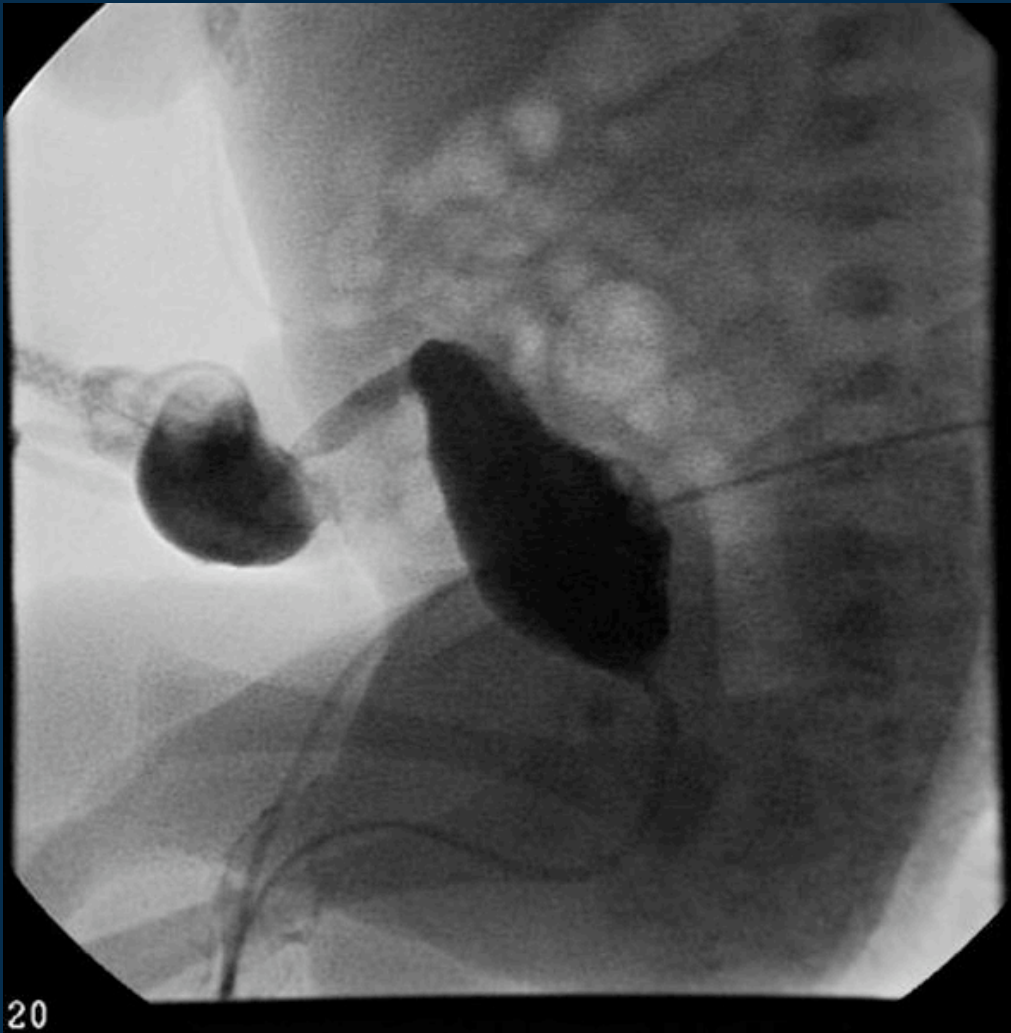
- **Urachal fistula:**
persistent allantois
-Urine drains from umbilicus
- **Urachal cyst:**
Part of allantois persists and secretes fluid resulting in cystic dilation



Bladder Defects

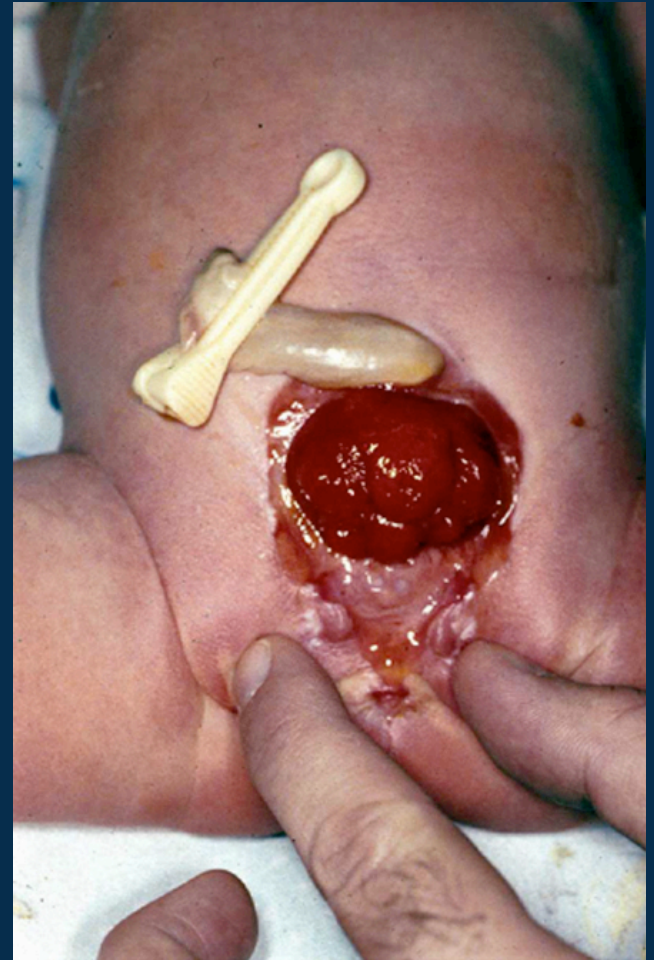


Bladder Defects



Bladder Defects

- **Bladder exstrophy:**
ventral body wall defect in which the bladder mucosa is exposed

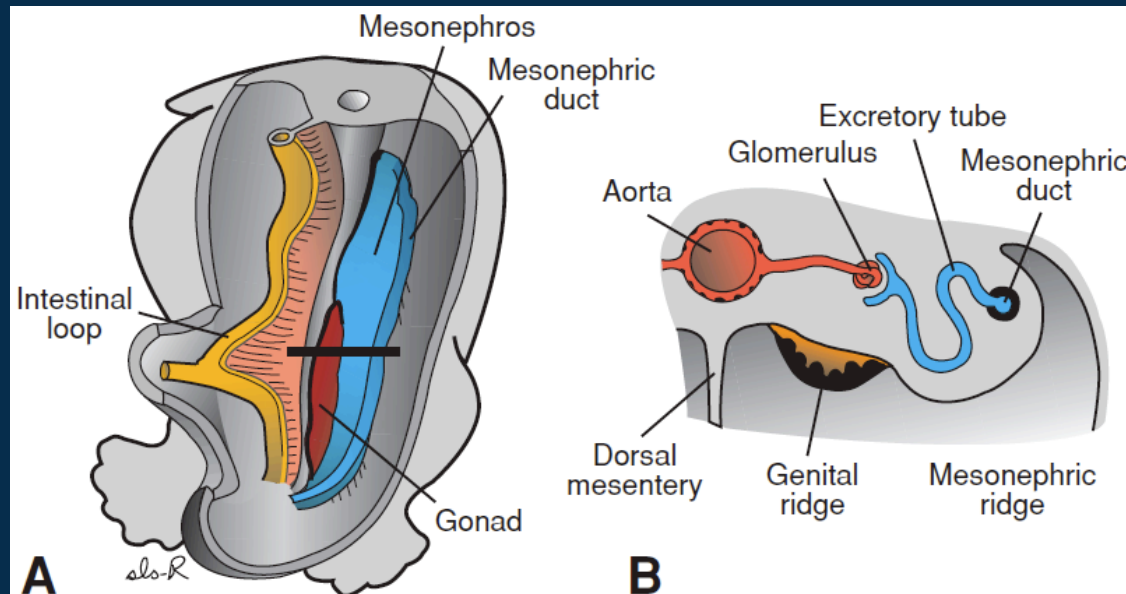


Part Two:

REPRODUCTIVE SYSTEM

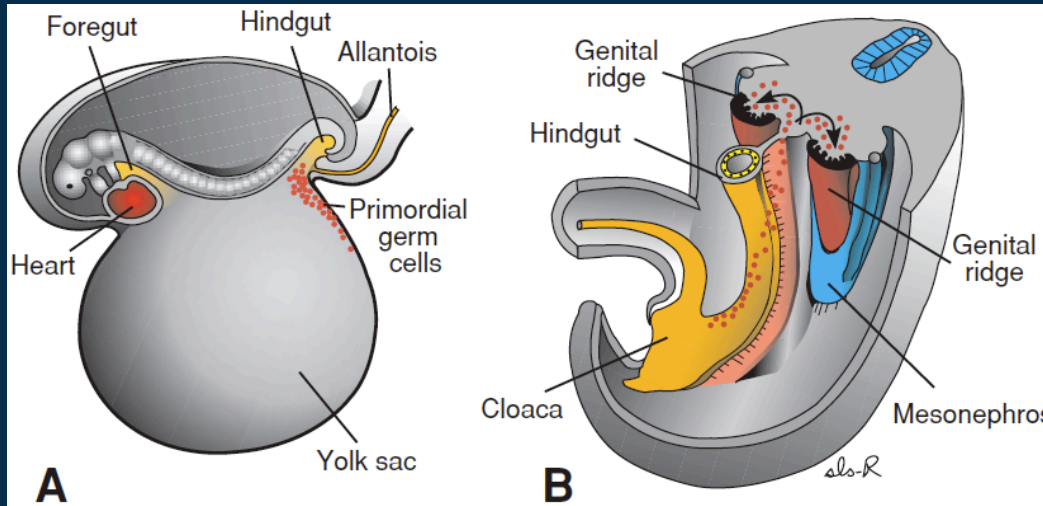
Gonads

- No M/F distinction till week 7
- **Genital ridge:** epithelium and mesenchyme
- Germ cells in ridge around week 6

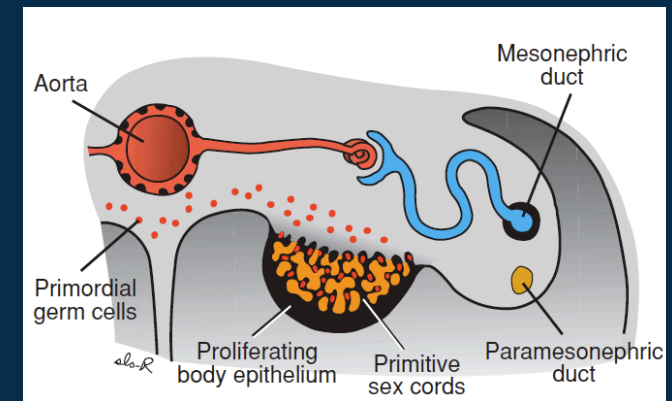


Primordial Germ Cell Migration

- Travel: yolk sac (wk 3) → genital ridges (wk 6)
- Gonads only develop if cells arrive (induction)
- **Primitive sex cords** form prior to arrival of cells

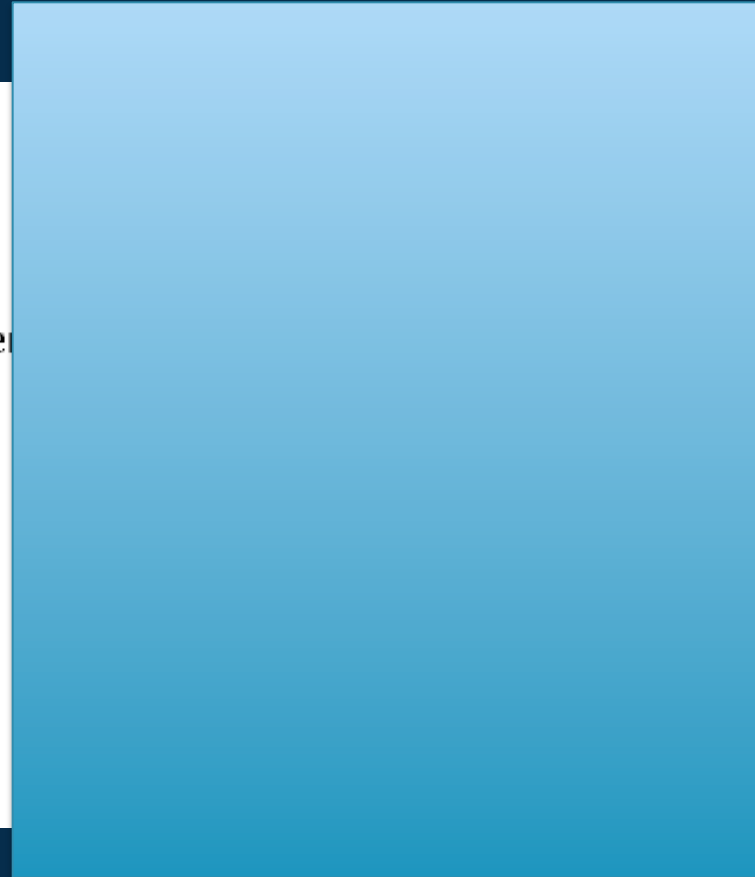
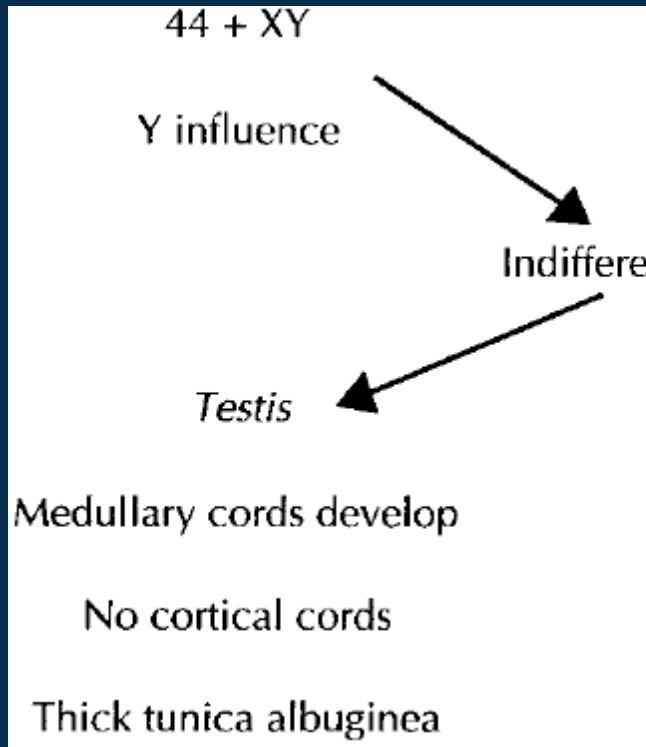


Week 3



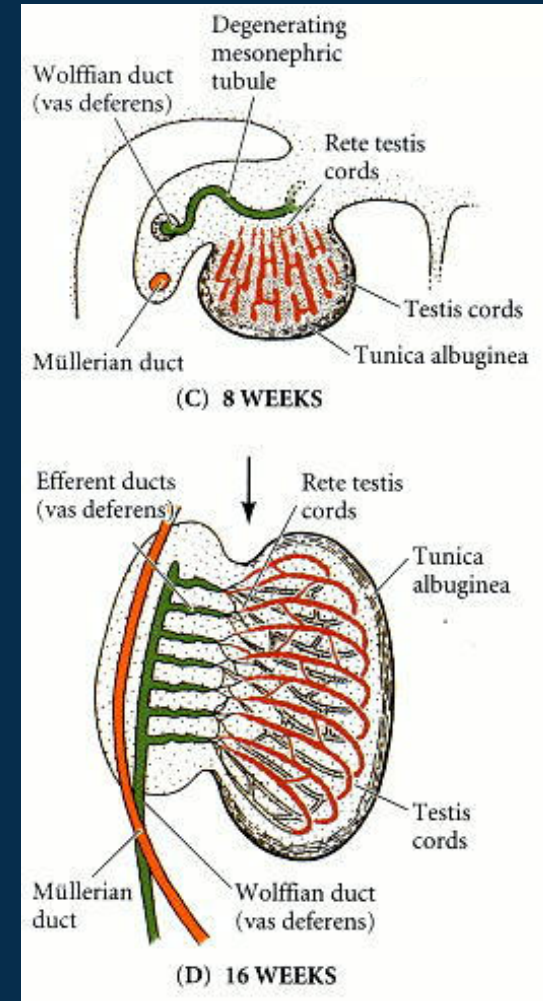
Week 6

Influence of Primordial Germ Cells

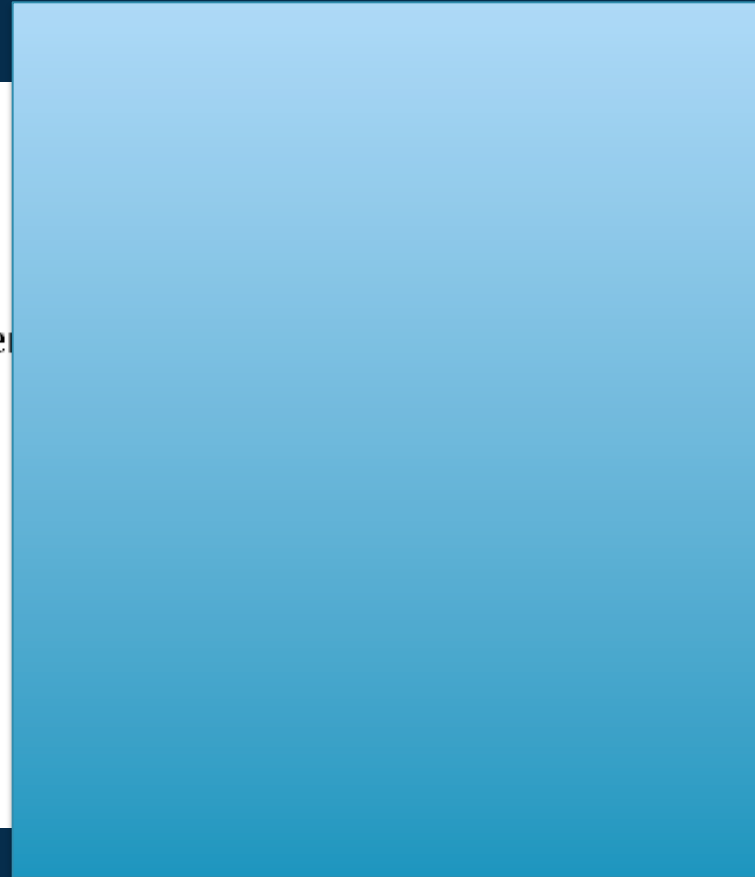
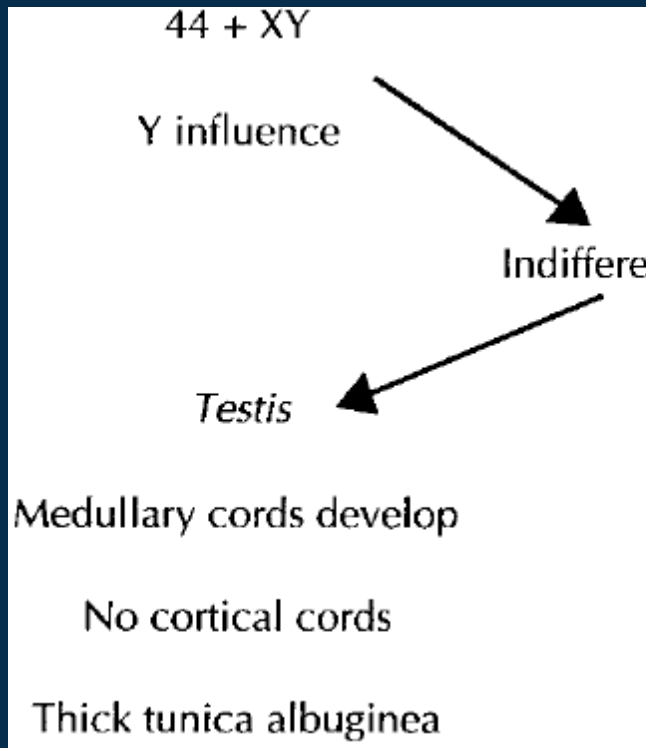


Testis Development

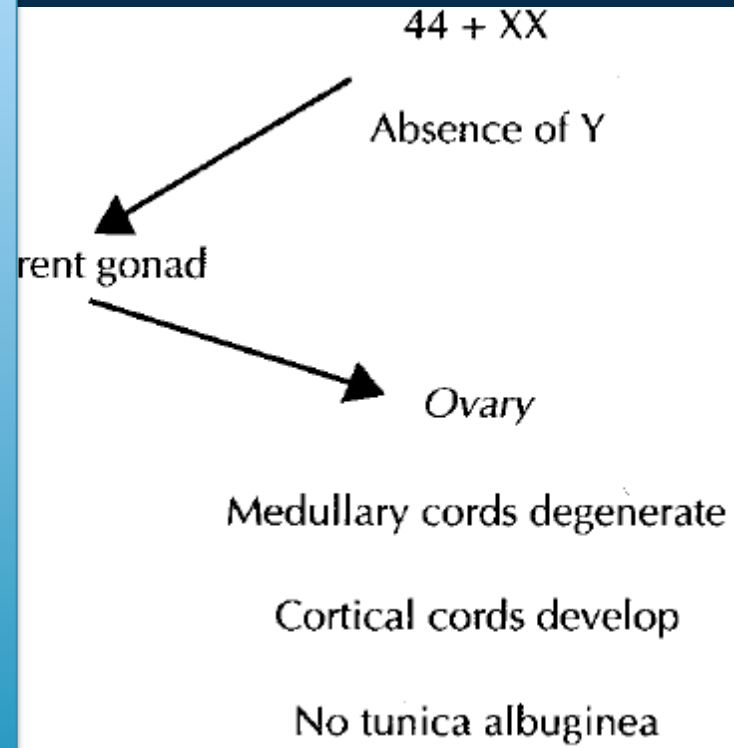
- **Testis Cords:** form from primitive sex cords
- **Rete Testis:** at hilum of gland
- **Tunica albuginea:** thickens to separate testis cords from surface epithelium
- **Sertoli cells:** derived from surface epithelium and lie between testis cords
- **Interstitial cells of Leydig**
-Produce testosterone



Influence of Primordial Germ Cells

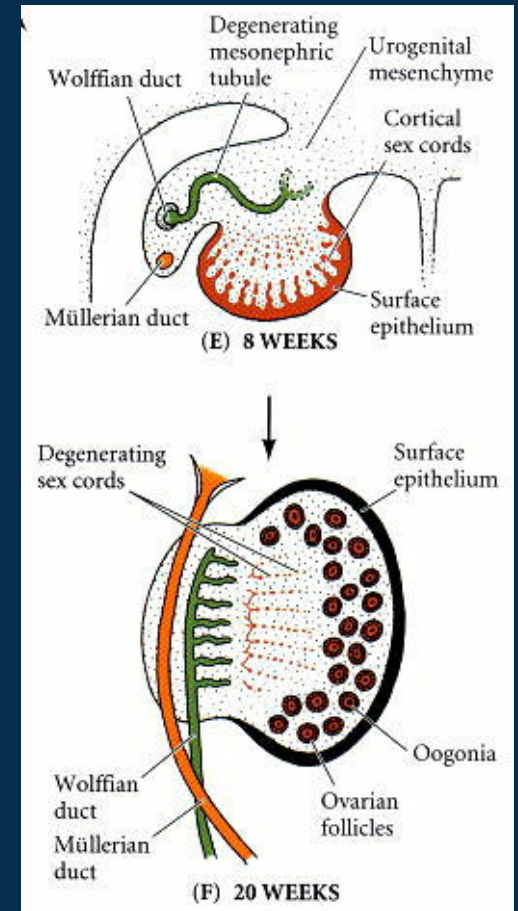


Influence of Primordial Germ Cells

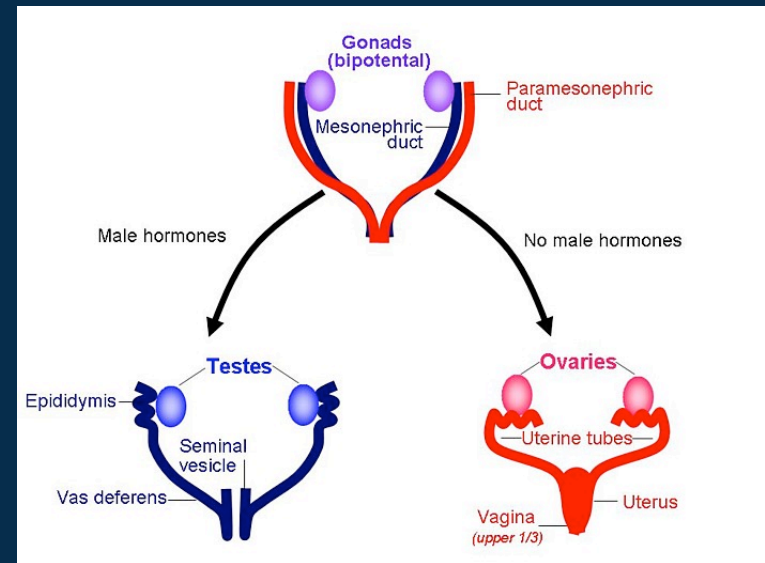
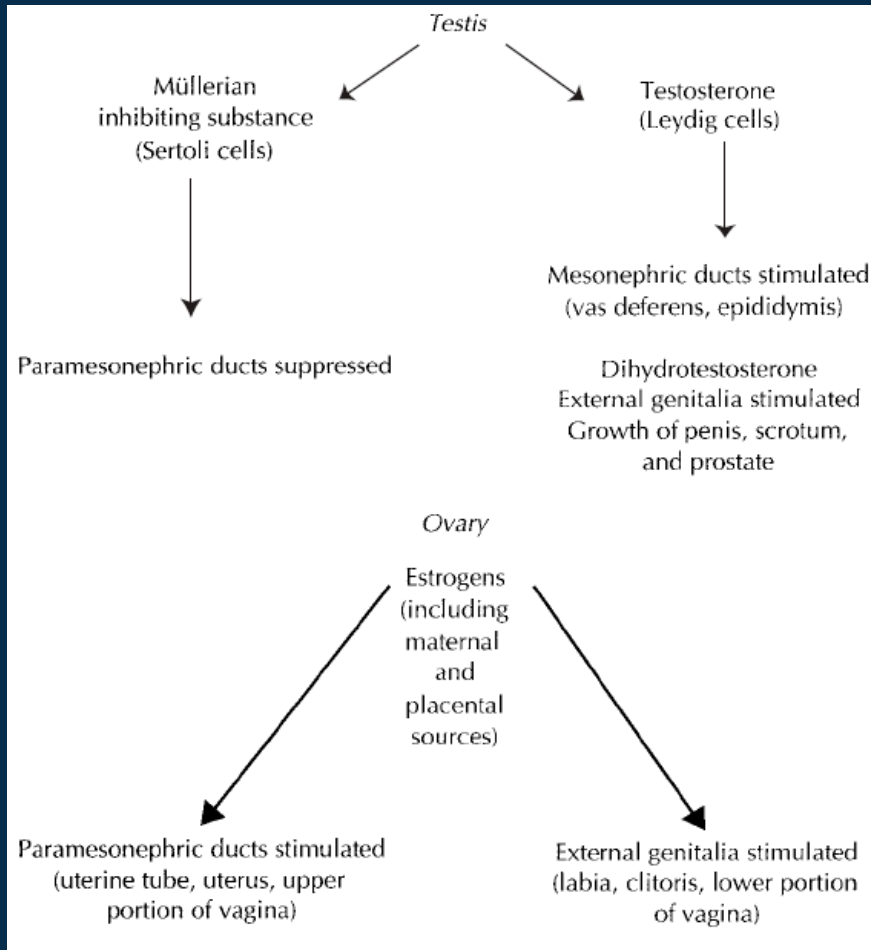


Ovary Development

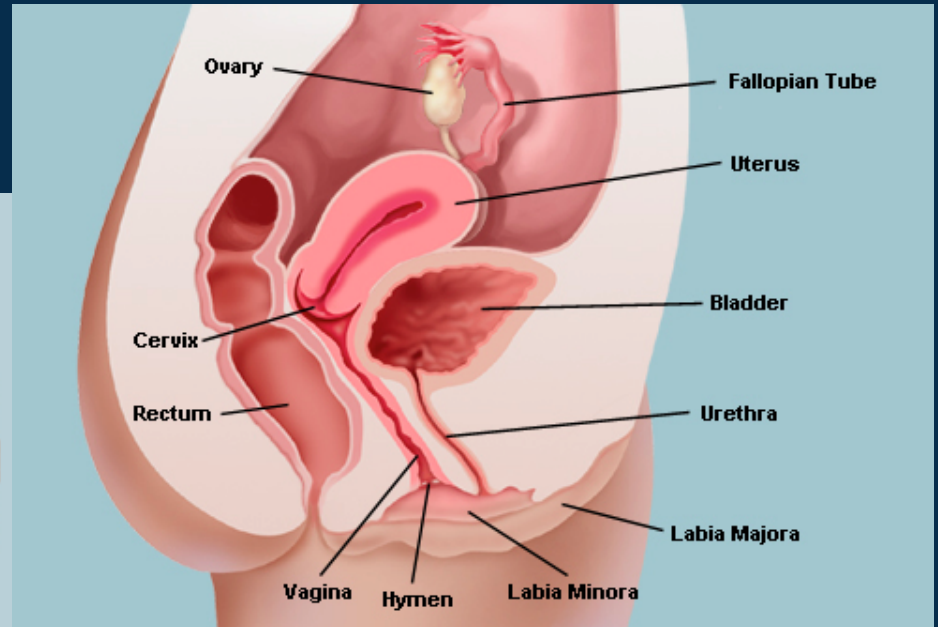
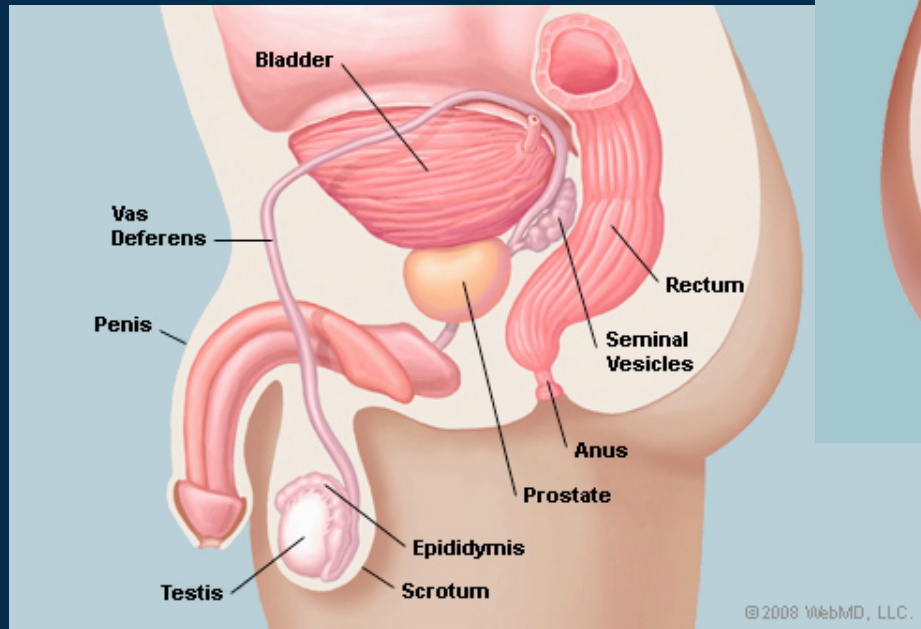
- Primitive sex cords replaced by vascular stroma
- Surface epithelium proliferates to form **cortical sex cords**
- Sex cords → cell clusters (4 mo)
- Primitive germ cells develop into **oogonia** (5 mo)
- Epithelial cells → **follicular cells**



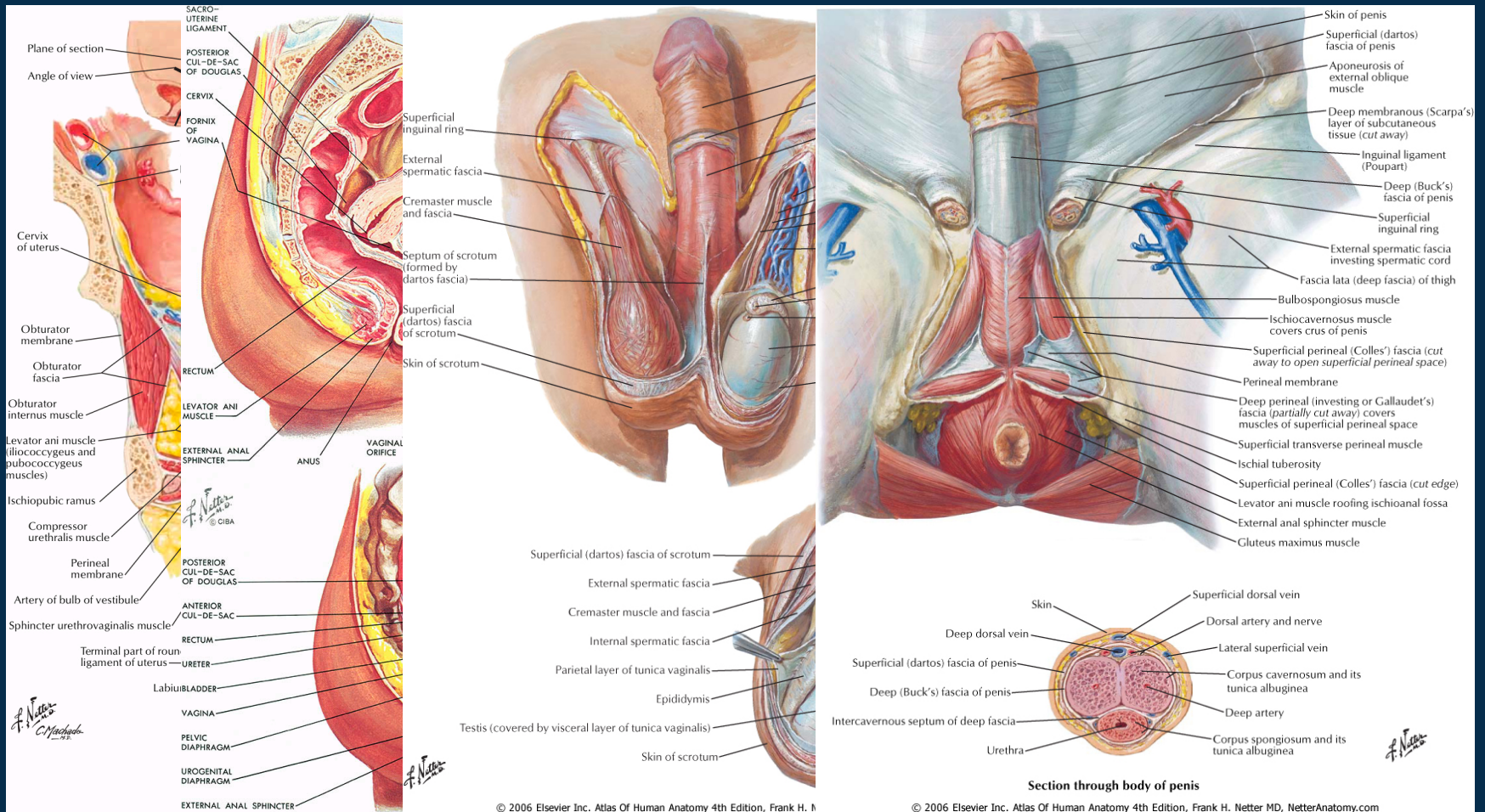
Genital Duct Development



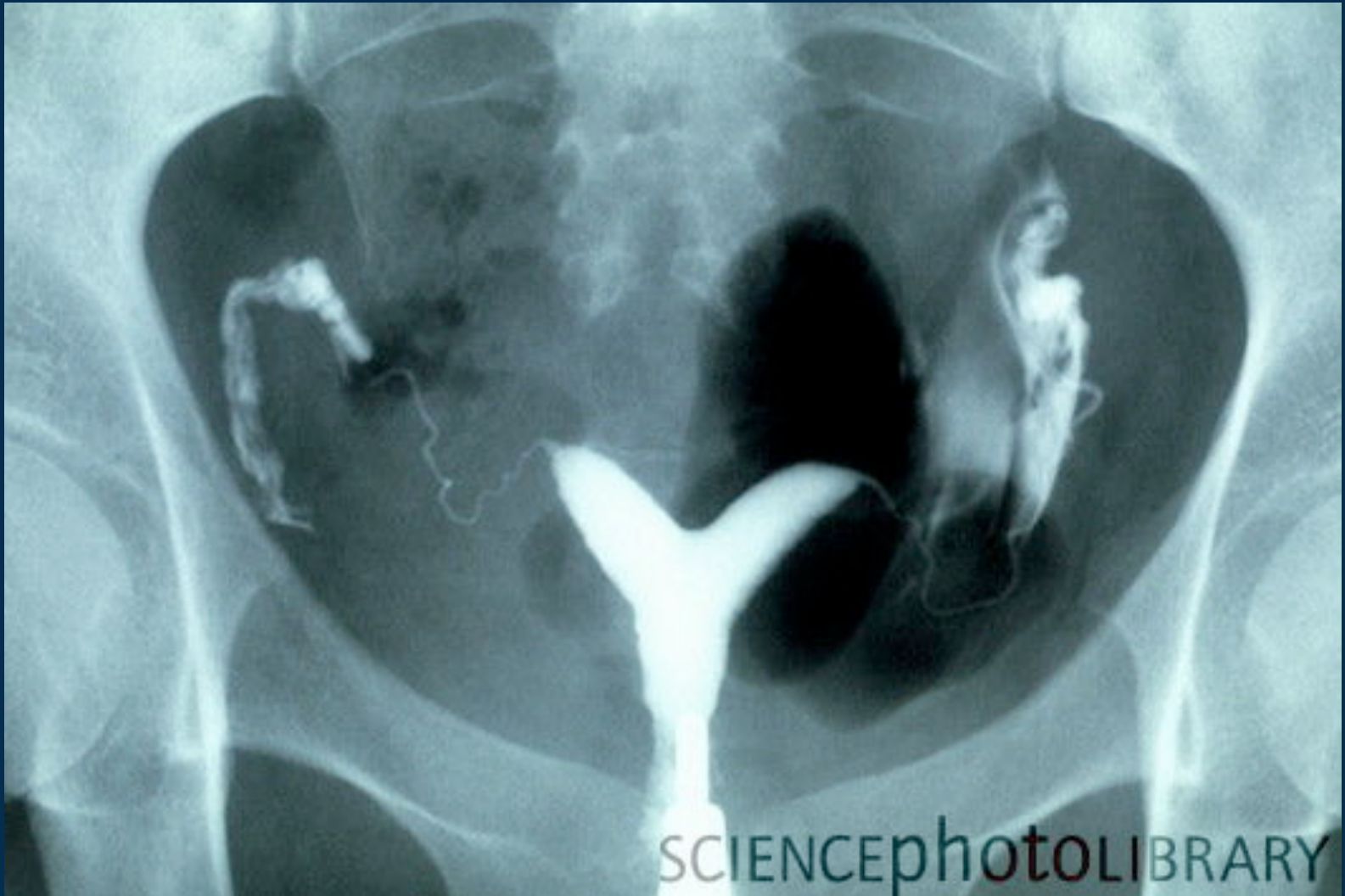
Internal Genitalia at Glance



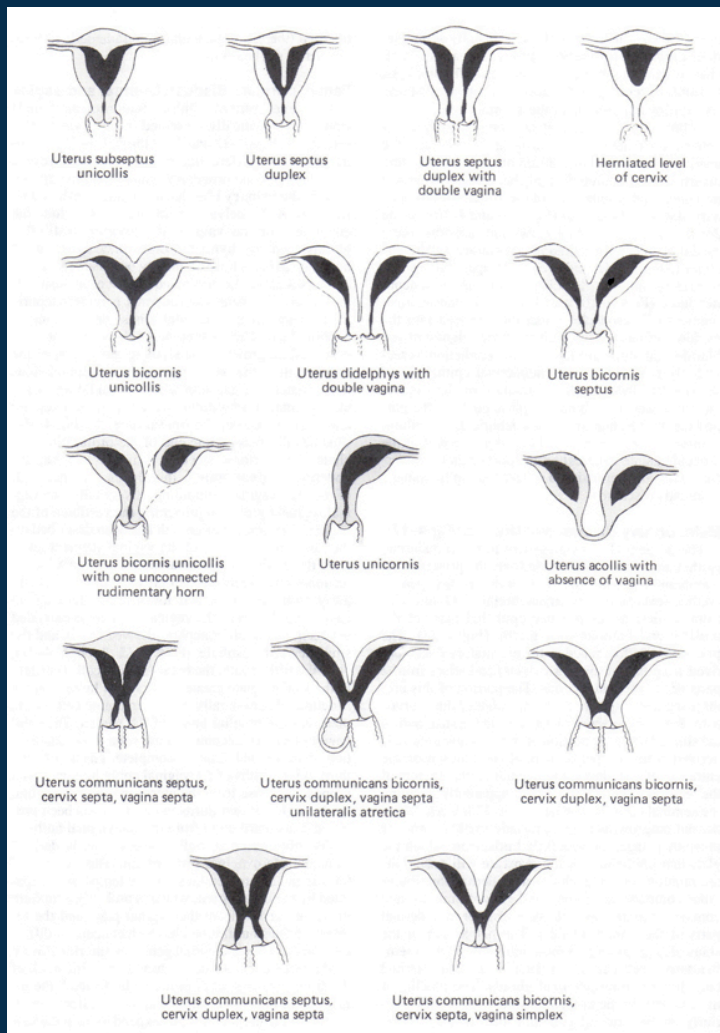
What you should know!



What's Abnormal?



Uterine and Upper Vaginal Duplications



Uterine and Upper Vaginal Duplications



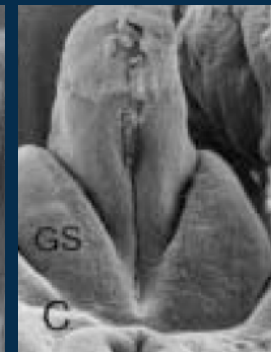
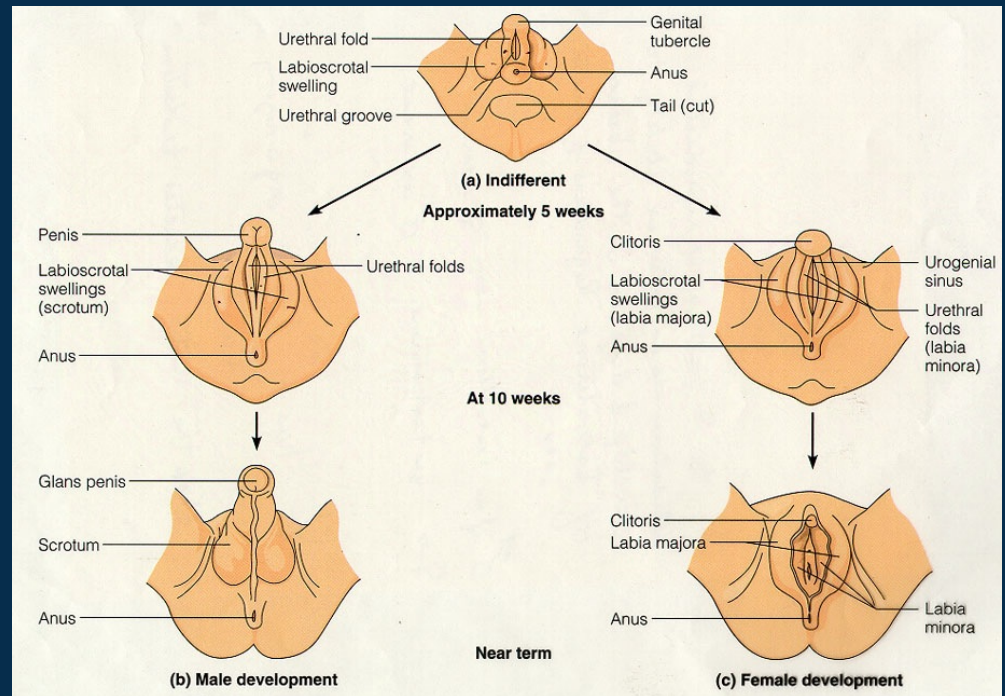
External Genitalia Development

Male: *Dihydrotestosterone*

- Genital tubercle** becomes the glans penis
- Urethral folds** become the phallus
- Labioscrotal swellings** become the scrotum.

Female: *Estrogen*

- Genital tubercle** becomes the clitoris
- Urethral folds** become the labia minora
- Labioscrotal swellings** become the labia majora



Defects in Male Genitalia



Hypospadias:

-Failure of urethral folds to close

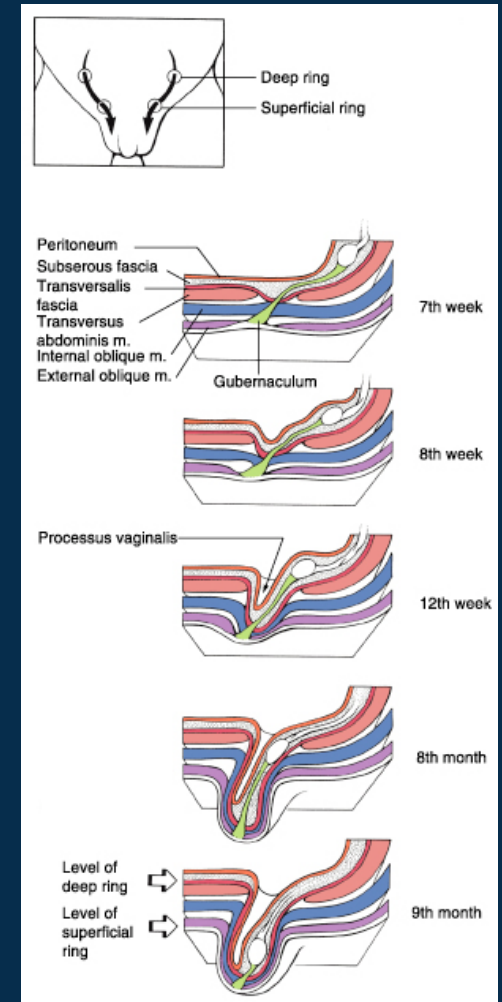


Epispadias:

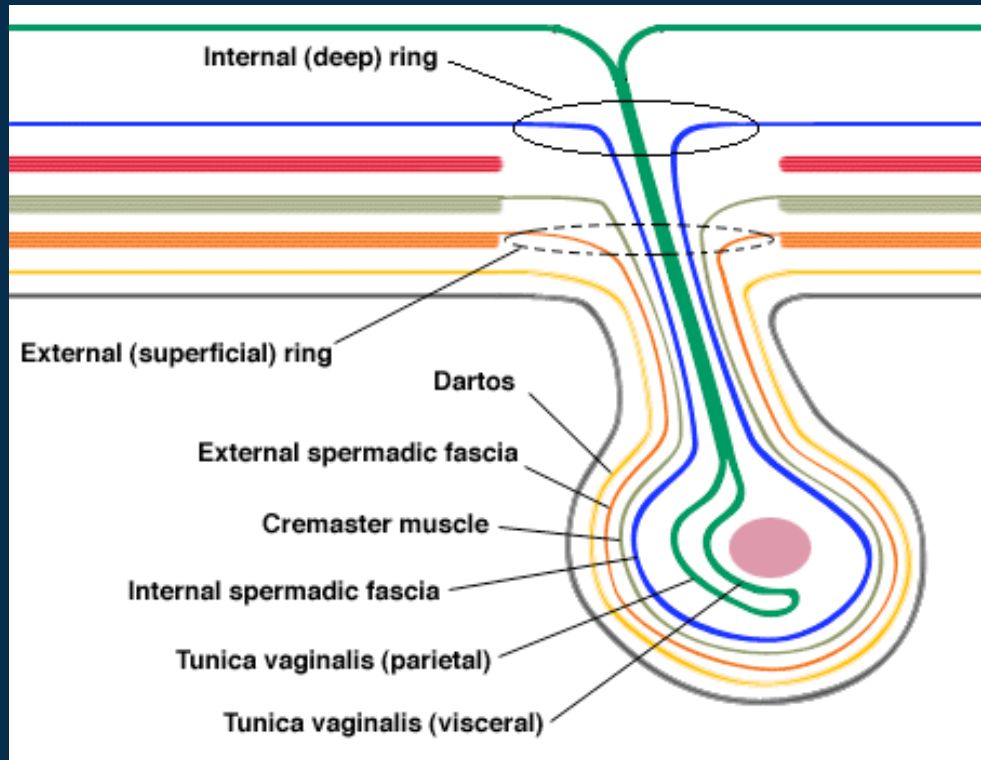
-Faulty positioning of genital tubercle
-Associated with bladder exstrophy

Descent of Testes

- **Gubernaculum** attached at caudal pole of testis
- Factors controlling descent:
 - Increased intra-abdo pressure
 - Shortening of gubernaculum
- Deep & superficial inguinal rings
- **Processus vaginalis**
- Inguinal canal allows passage into scrotum



Layers of Testis

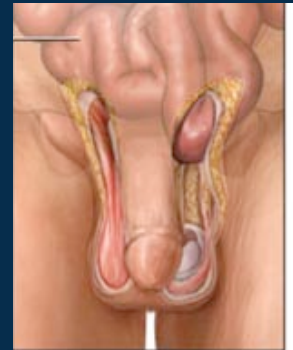


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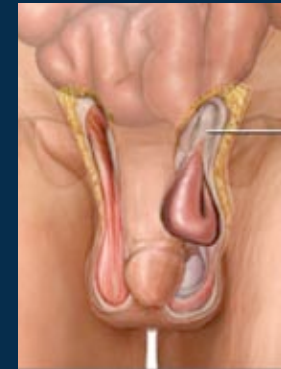
“Some Damn Englishmen Call It Testes”
Skin, Dartos, External spermatic fascia, Cremaster muscle,
Internal spermatic fascia, Tunica vaginalis

Clinical Correlates

- **Indirect inguinal hernia:** lateral to IE artery
 - Failure of processus vaginalis to close
 - Intestines pass through both rings into scrotum
 - Usually seen in male infants
- **Direct inguinal hernia:** medial to IE artery
 - Intestines pass directly through abdominal wall
 - Through superficial inguinal ring only
 - Covered by external spermatic fascia
- **Hydrocele:** Processus vaginalis open, cysts form, cysts secrete fluid that builds up



Indirect inguinal hernia



Direct inguinal hernia



Clinical Correlates





Questions?

Med School Advice:

- Buy a copy of **First-Aid for USMLE Step 1** now → learn over two-year period
- Read **Apps of Steel by Donna Magid** (www.TeamRads.com) and plan ahead
- Use **Vertical Advisory**: Deans, College Advisors/Dr. Magid, and other students
- Have fun in med school...the time flies by!**

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