GUS..

Lecture (3)

Embryology of Urinary System

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ILOs

1-Understand the normal development of:

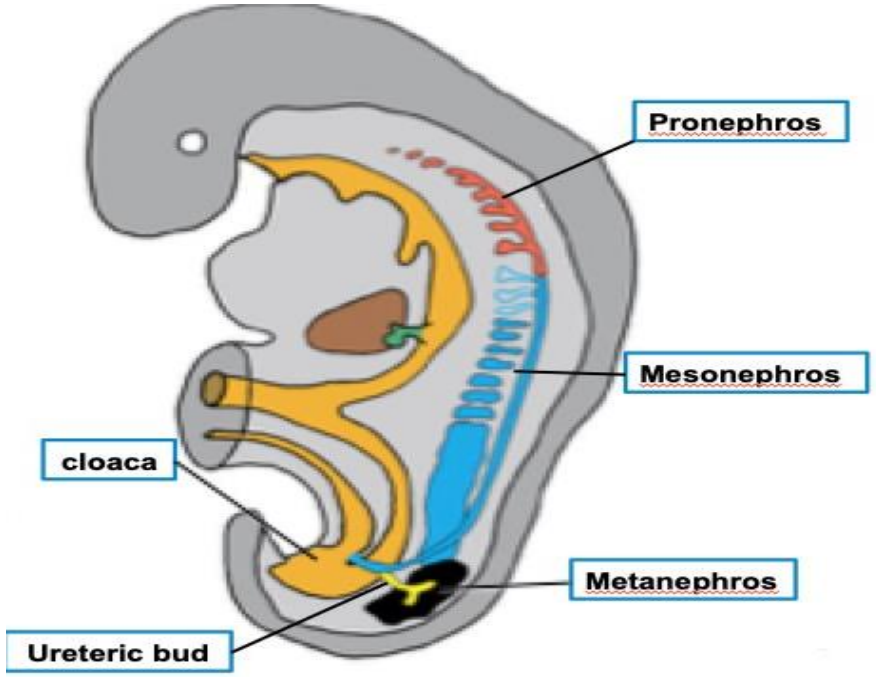
- **Kidneys.**
- **Ureters.**
- **Urinary bladder.**
- **Urethra.**

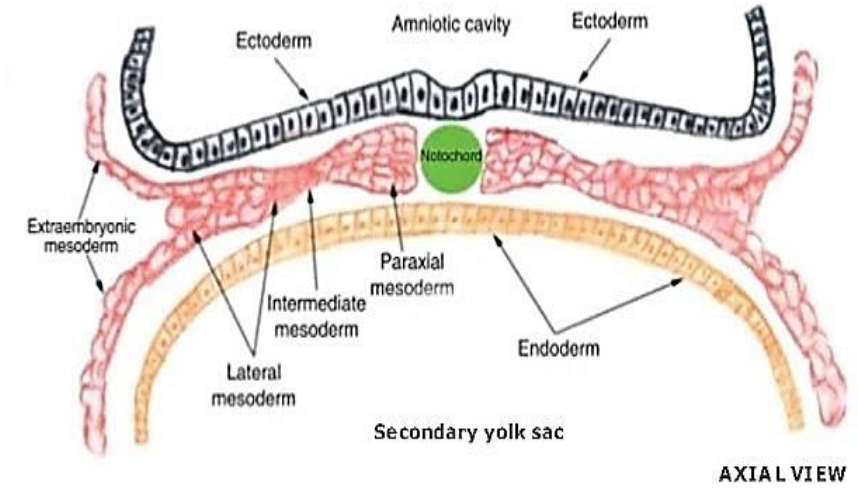
2-Understand congenital anomalies of the urinary system.

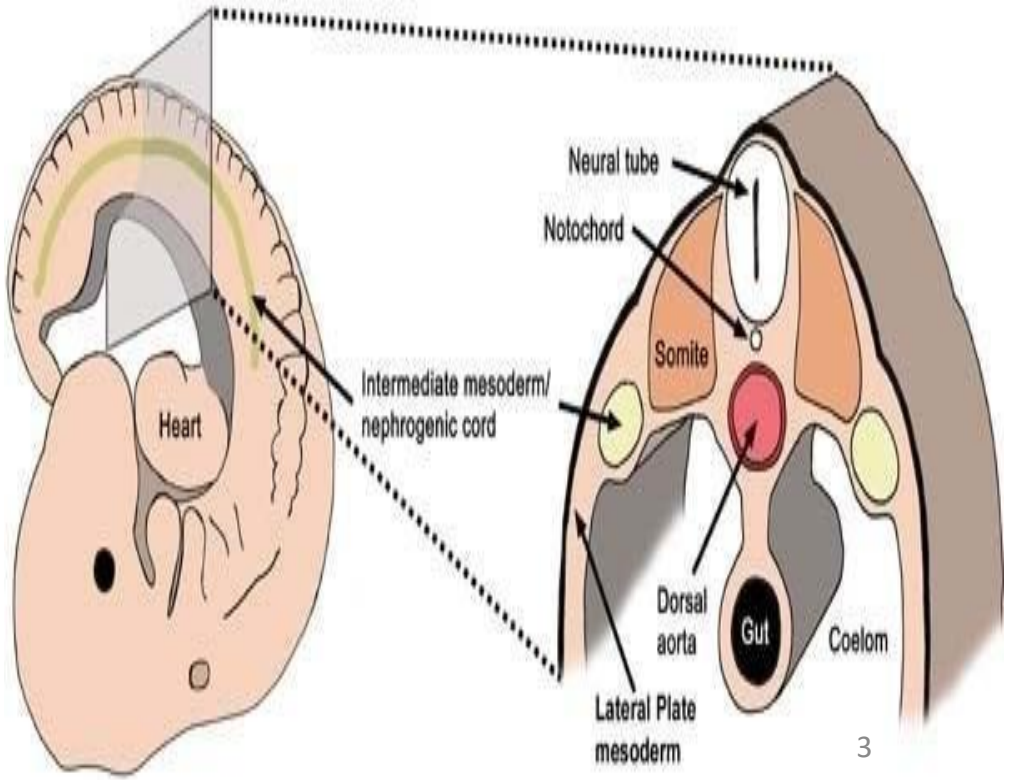
Development of Kidney

- It is developed from **Intermediate Mesoderm**.

- Upper part of intermediate mesoderm segmented (**nephrotomes)** and lower part non segmented form **nephrogenic cord.**







Stages of development of the kidney:

- **It develops in 3 stages in craniocaudal direction;**

  Pronephros, Mesonephros and Metanephros.

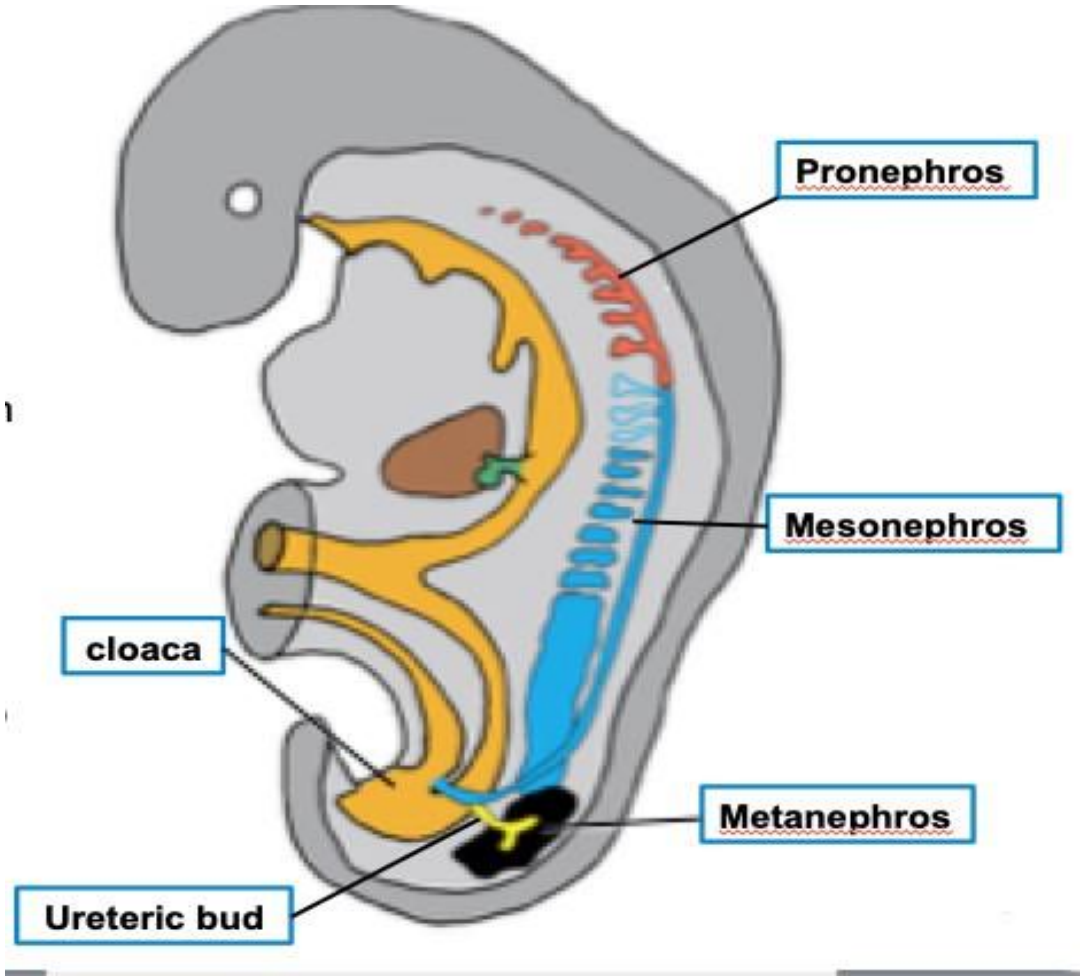
1- Pronephros:

Development:

- In 4th week of development.
- Developed from cephalic part of intermediate mesoderm.

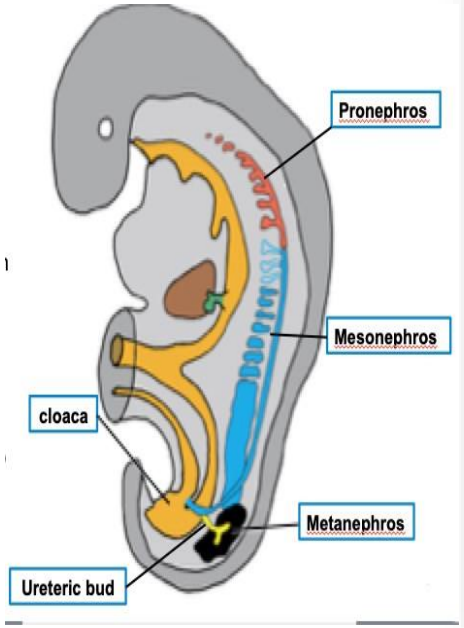
Fate of pronephros:

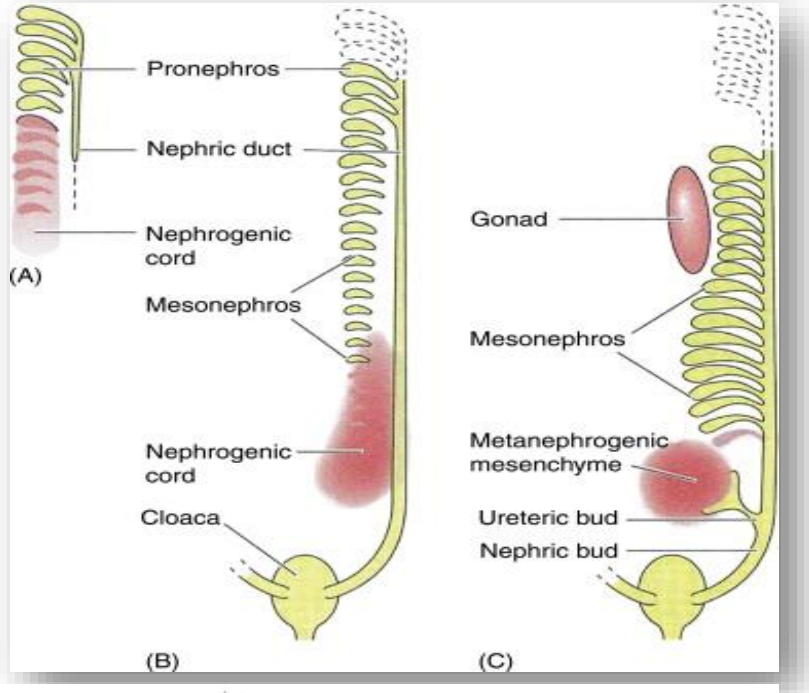
- In human: Functionless & transient, degenerate at 4th week.
- It is **inductor** for formation of mesonephros (2nd kidney).



2-Mesonephros:

- It is **developed** from thoracic and upper lumbar parts of intermediate mesoderm.
- 70-80 **mesonephric tubules** (called mesonephros, second kidney) are formed.





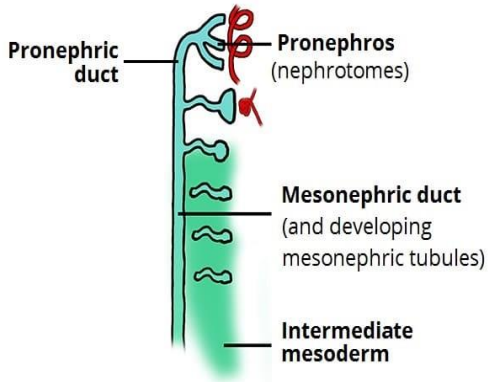
- **Each tubules is S shaped with two ends;**

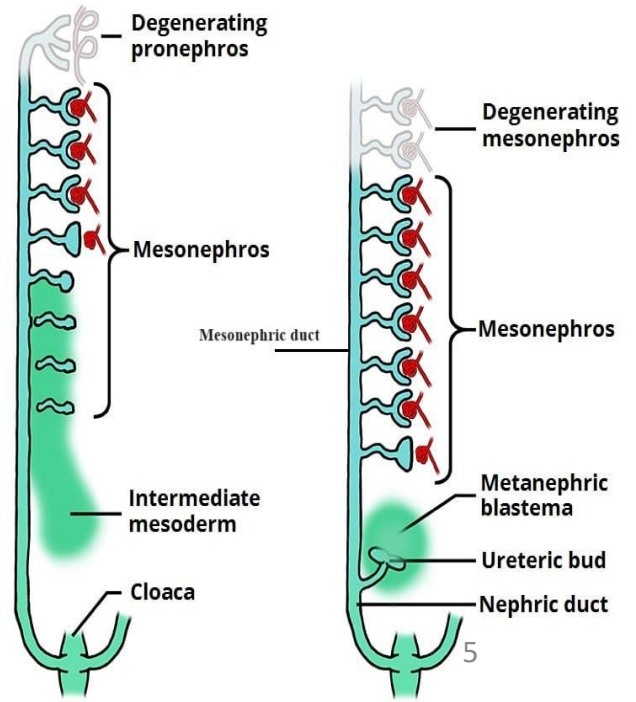
➢ **Medial (cup shape) end:**

- Invaginated by tuft of capillaries from dorsal aorta forming the glomerulus.

➢ **Lateral end:**

- Open in mesonephric duct (wolffian duct).





- **Second kidney** excrete urine between the sixth and tenth weeks of embryological life.

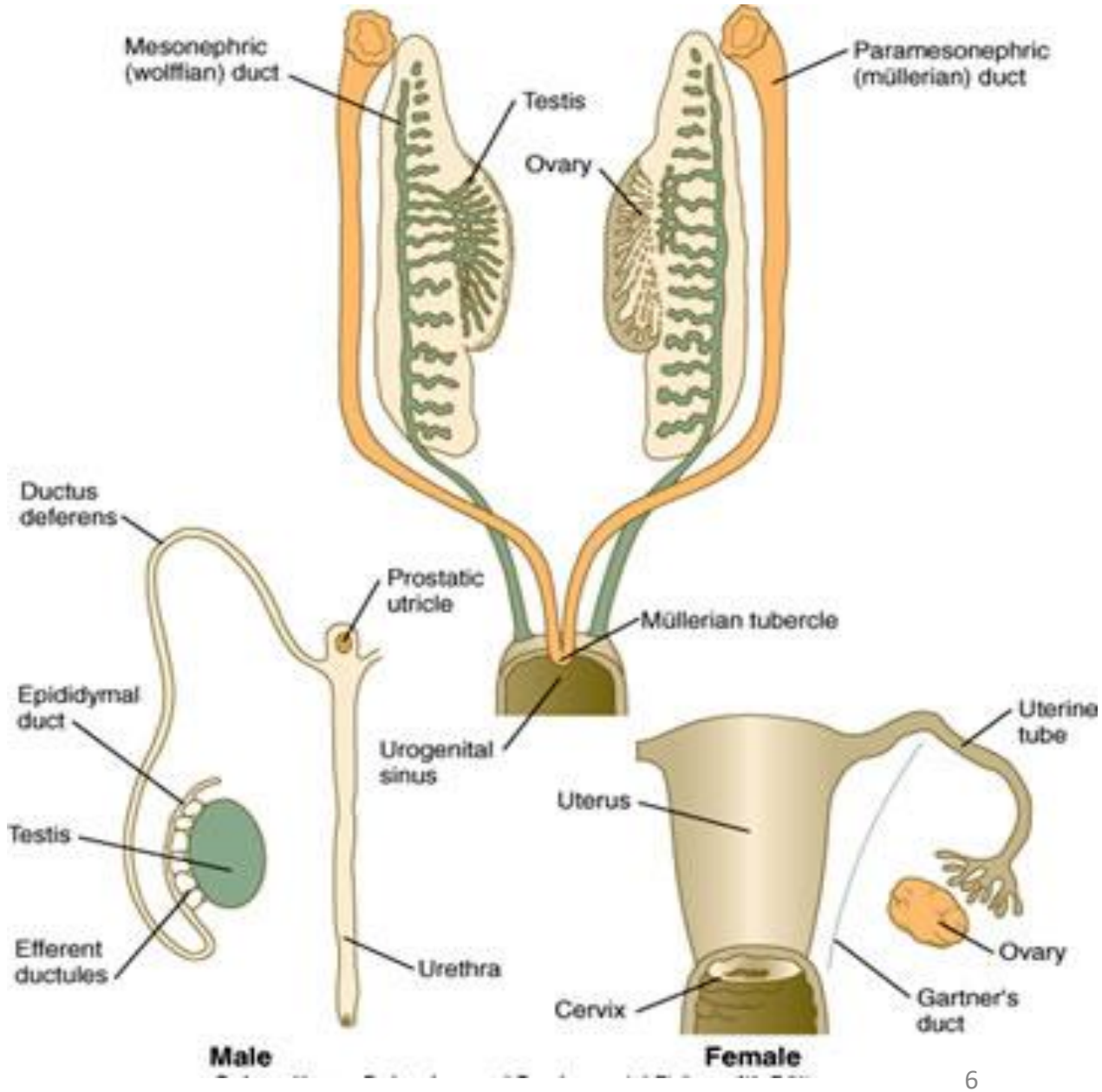
Fate of Mesonephros:

a) Fate of mesonephric tubules:

- **Majority of mesonephric tubules** disappear &glomeruli degenerate and disappear by the end of second month.
- **Some persist (middle group)& give rise to:**

○ Efferent ductules in male.

○ Epoophoron in female.



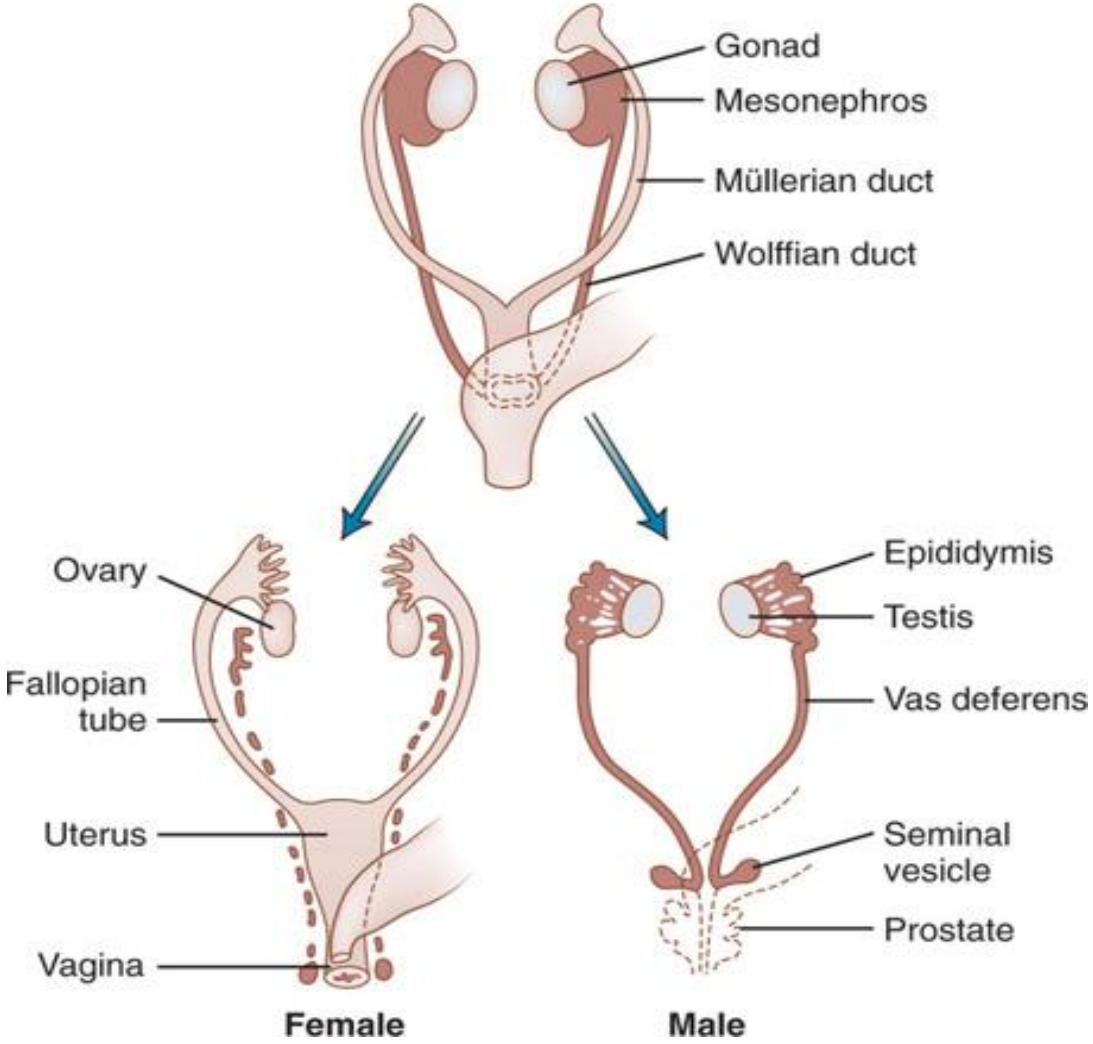
b)Fate of mesonephric (wolffian) duct:

In males

- Body & tail of epididymis.
- Vas deferens.
- Seminal vesicle.
- Ejaculatory duct.

In females

- Mostly degenerated.
- Part of duct remains forming duct of epoophoron.



In both male& female:

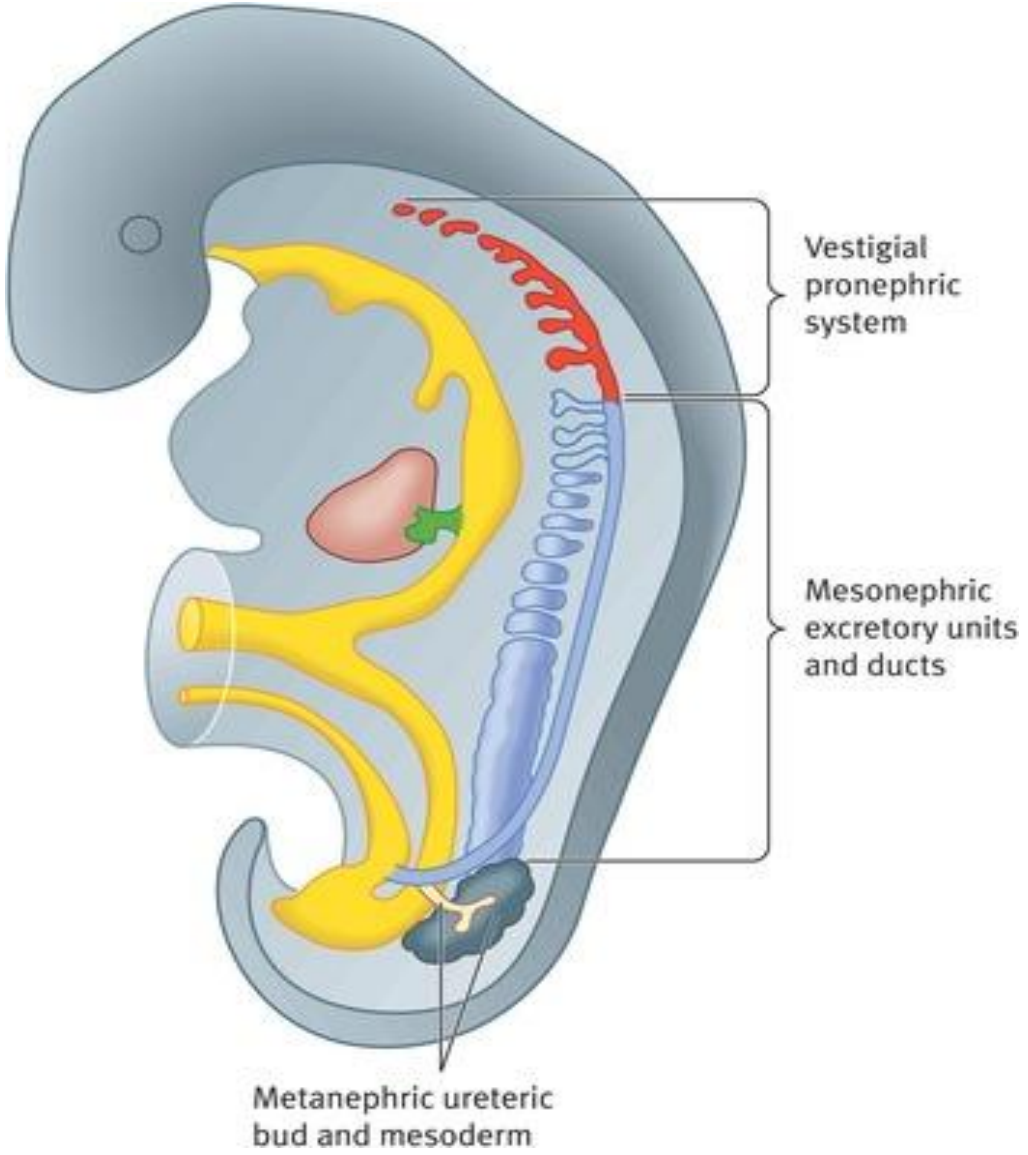
- Its most caudal part **absorbed into the cloaca &** gives **the ureteric bud.**

3-Metanephros:

- **It** is the **permanent kidney.**
- **It develops from two sources:**

1- Metanephric cap.

2- Ureteric bud.

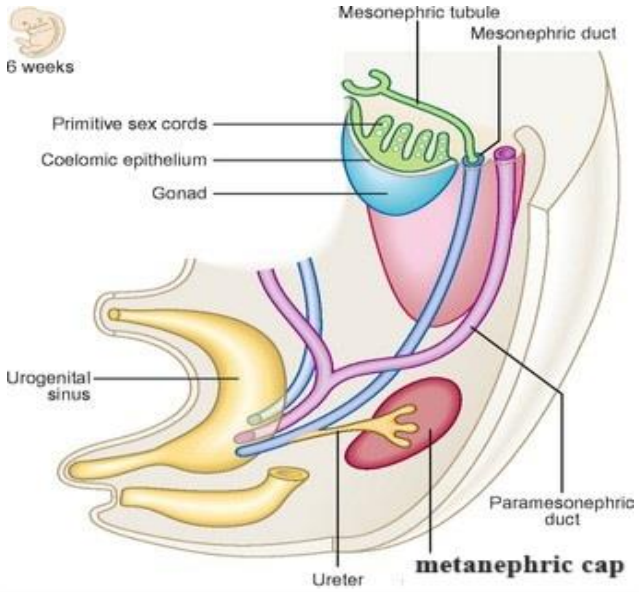


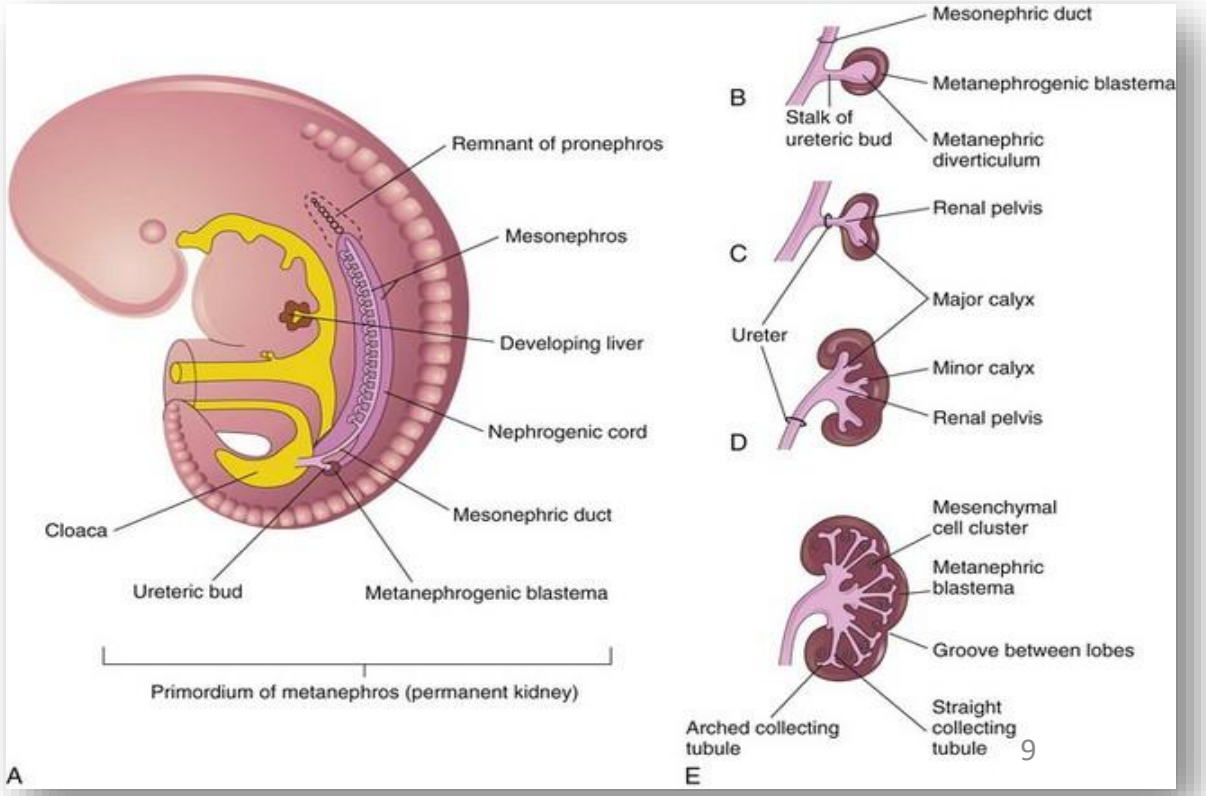
1- Metanephric cap:

- **It is developed from** caudal part of intermediate mesoderm.
- It forms the **Nephrons.**

2- Ureteric bud:

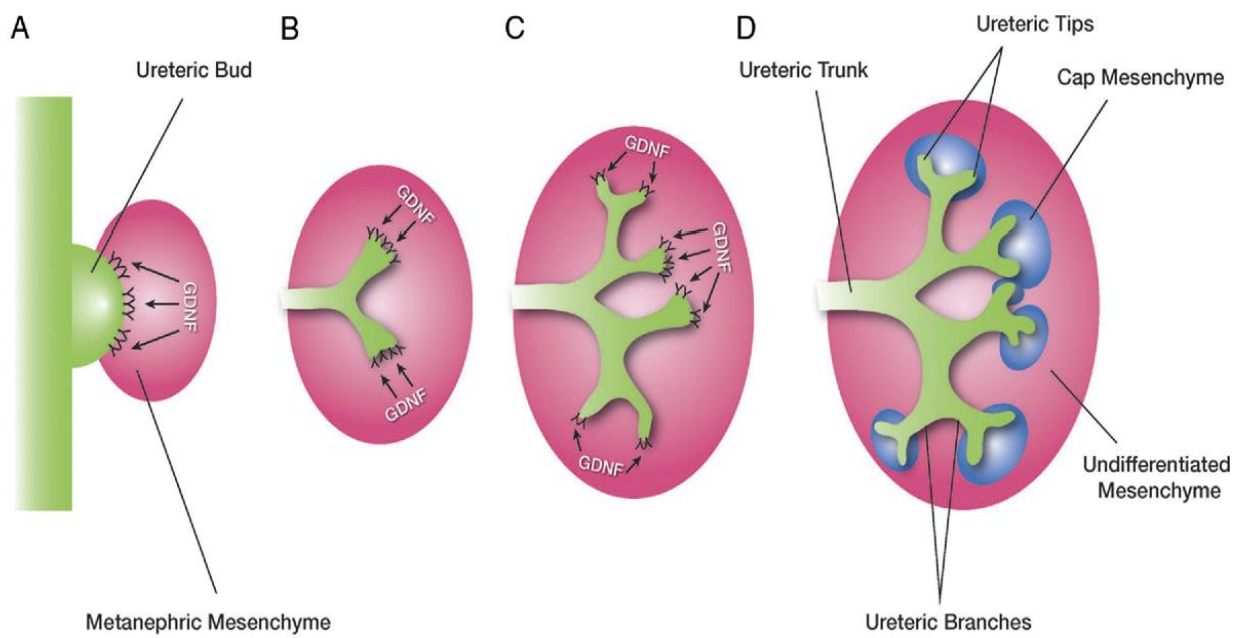
- **It develops from caudal part of mesonephric duct.**
- **It forms collecting part of kidney.**
- The bud **elongates** cranially **to touch** metanephric cap.
- **Expansion of cranial end of ureteric bud** → form renal pelvis that branch → 2-3 major calyces → minor calyces → collecting tubules.





The metanephric cap:

- The **ureteric bud stimulates** division of metanephric cap into number of masses surround distal end of uretric bud divisions forming **metanephric cap** that differentiate into nephrons.



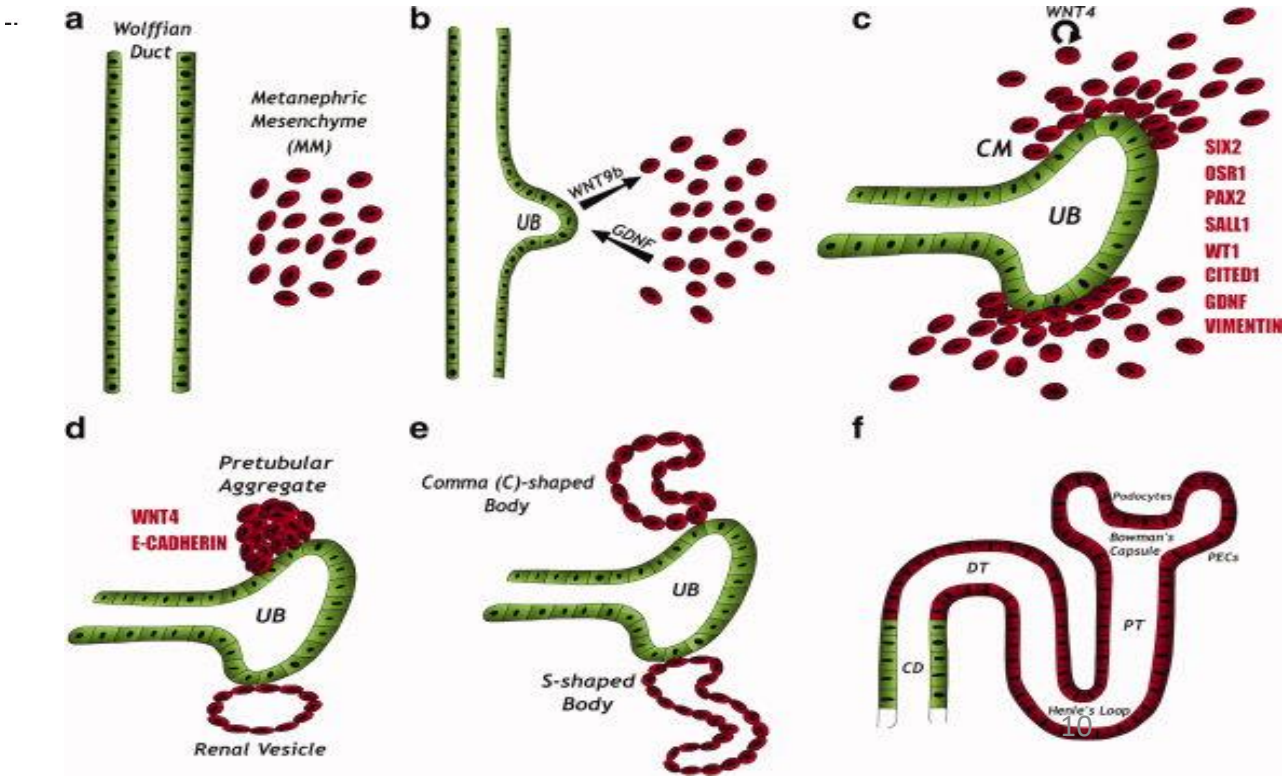
The nephron has 2 ends.

One end (Bowman's capsule)

Invaginated by tuft of capillaries from dorsal aorta forming glomerulus.

Other end

Open in corresponding collecting tubule.



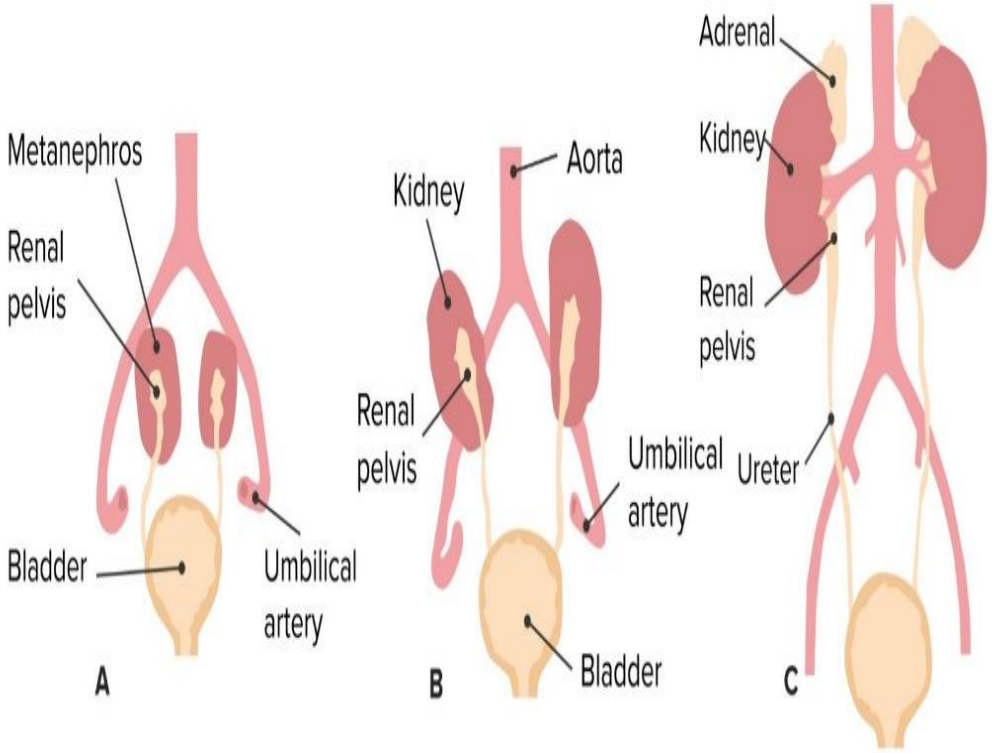
- **Further growth of nephron will form** PCT, loop of Henle and DCT.

In early development of the kidney:

- It lies in pelvis.
- Its concave border facing ventrally and the convex one facing dorsally.
- Its blood supply from pelvic vessels.
- Lobulated kidney.

Later on:

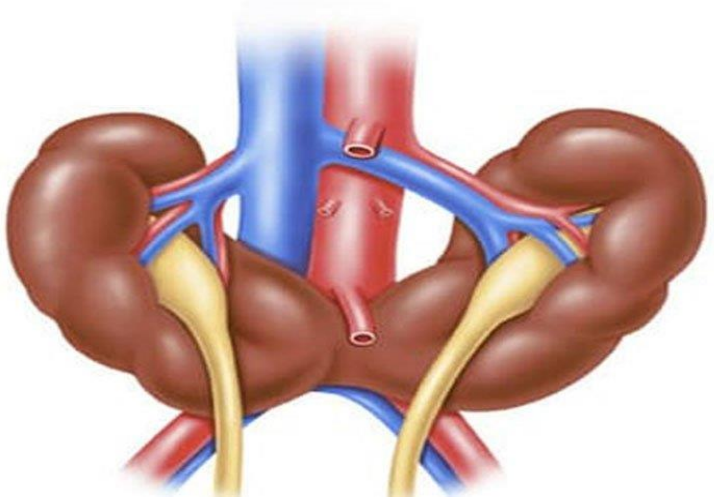
- **It ascends** to lumbar region due to elongation of ureter, decrease of body curvature and growth of lumbar & sacral regions.
- **During ascend**; it rotates 90 medially → concave border become medial &convex border become lateral.
- In lumbar position, it takes blood supply from abdominal aorta.
- Lose lobulation & becomes smooth due to growth of nephrons.



Congenital Anomalies of Kidney

1- Unilateral renal agenesis:

- Only one kidney is developed and the other one is **absent,** due to failure of development of metanephric cap or no touch between it & ureteric bud.



2- Unilateral Renal hypoplasia:

- **Small** sized kidney.

3- Horseshoe kidney:

- **The lower ends of the kidneys are fused** together with limited ascent, stop at inferior mesenteric artery.

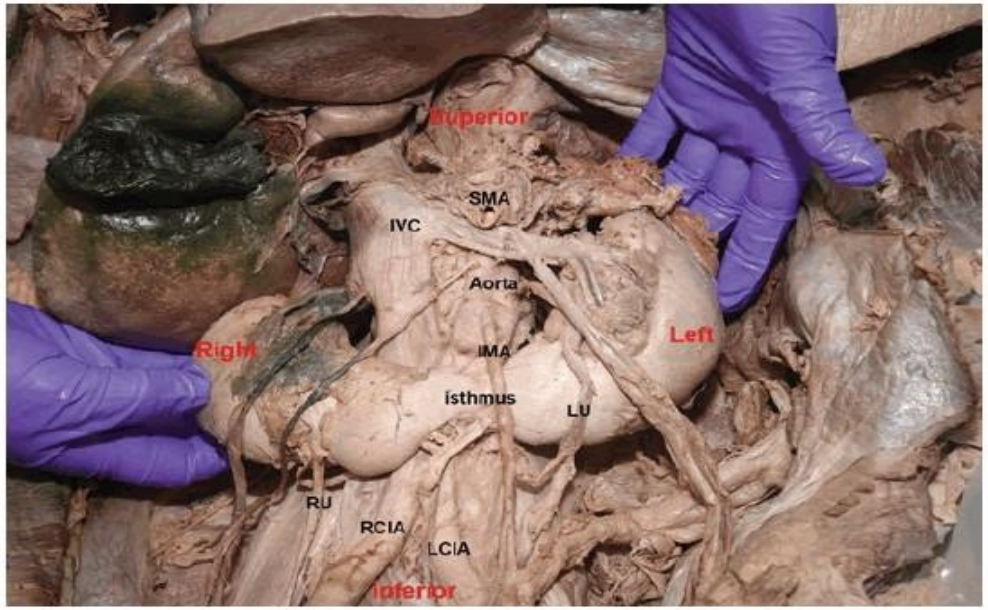


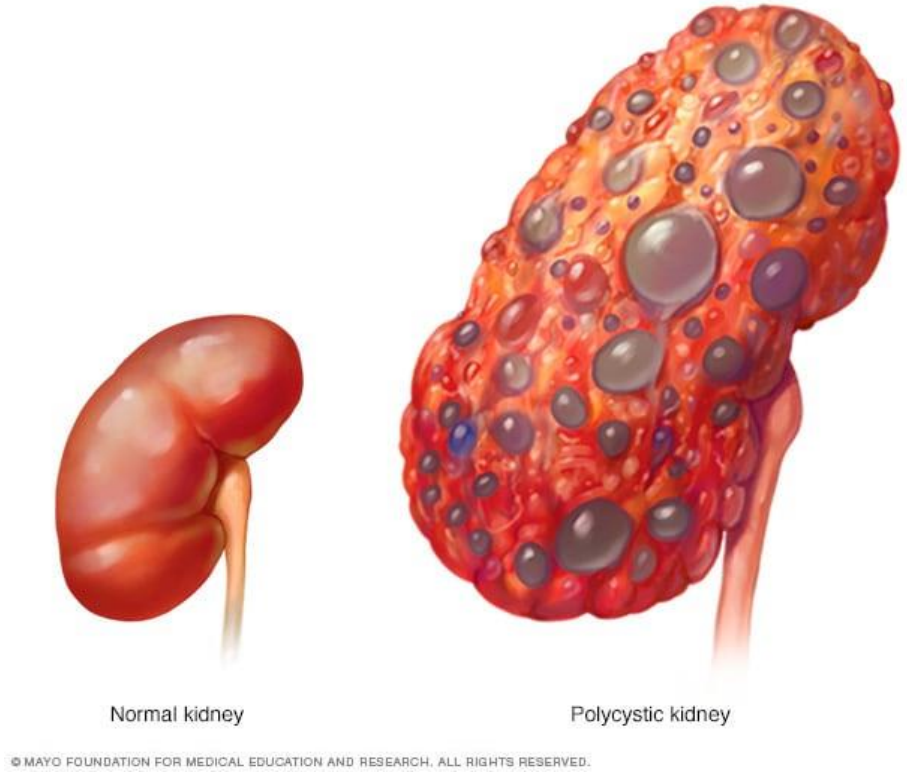
Figure 1) *Anterior view of the horseshoe kidney with the superior-lateral aspects of both kidneys elevated from the posterior abdominal wall to facilitate focusing of the image. The orientation of the image is indicated by superior, inferior, left and right. IMA: Inferior Mesenteric Artery; IVC: Inferior Vena Cava; LCIA: Left Common Iliac Artery; LU: Left Ureter; RCIA: Right Common Iliac Artery; RU: Right Ureter; SMA: Superior Mesenteric Artery.*

4- Pelvic kidney:

- kidney fails to ascend to its final lumbar position.

5- Congenital Polycystic kidney:

- It is thought to be caused by **a failure of union** between the developing convoluted tubules and collecting tubules. The accumulation of urine in the proximal tubules results in the formation of retention cysts.



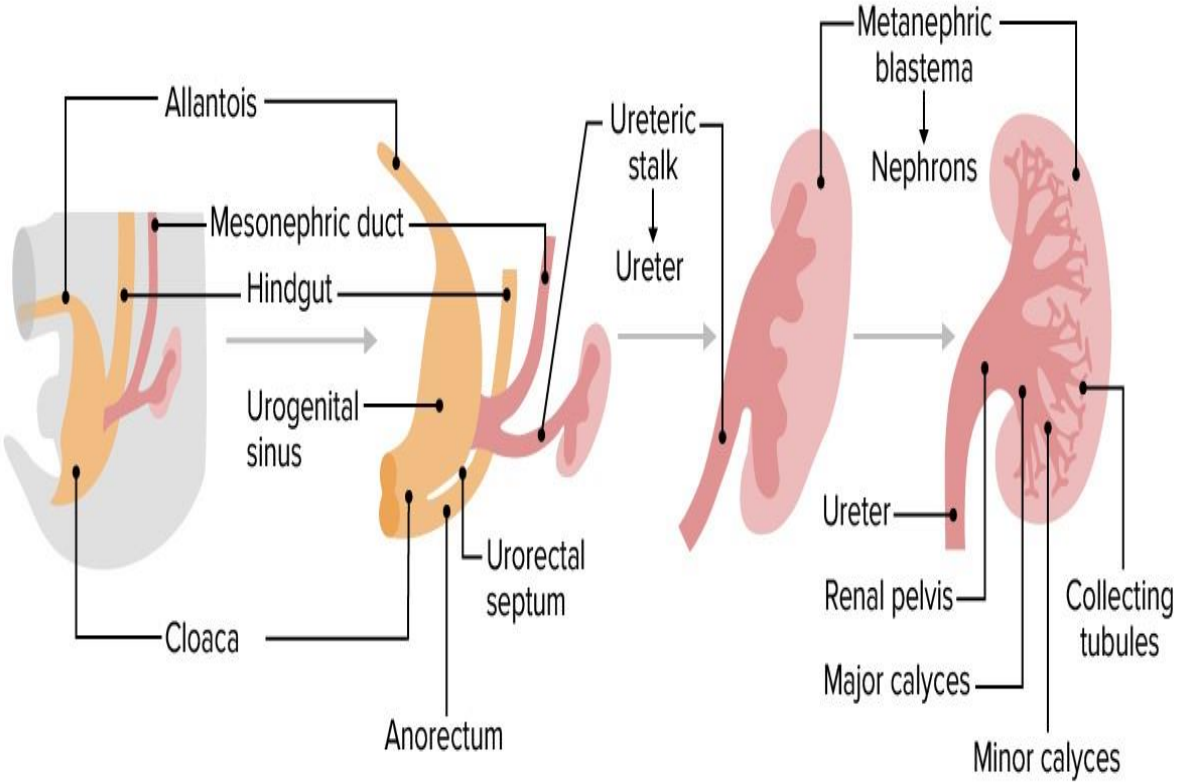
Development of Ureter

Developmental source:

- **Ureteric bud.**

Development:

- **Ureteric bud develops from** lower end of mesonephric duct near its entrance in cloaca.
- **The bud elongates** dorsally and cranially to touch metanephric cap.
- Upper end of bud dilates & divides repeatedly to form→ renal pelvis then major calyces-minor calyces & collecting tubules.



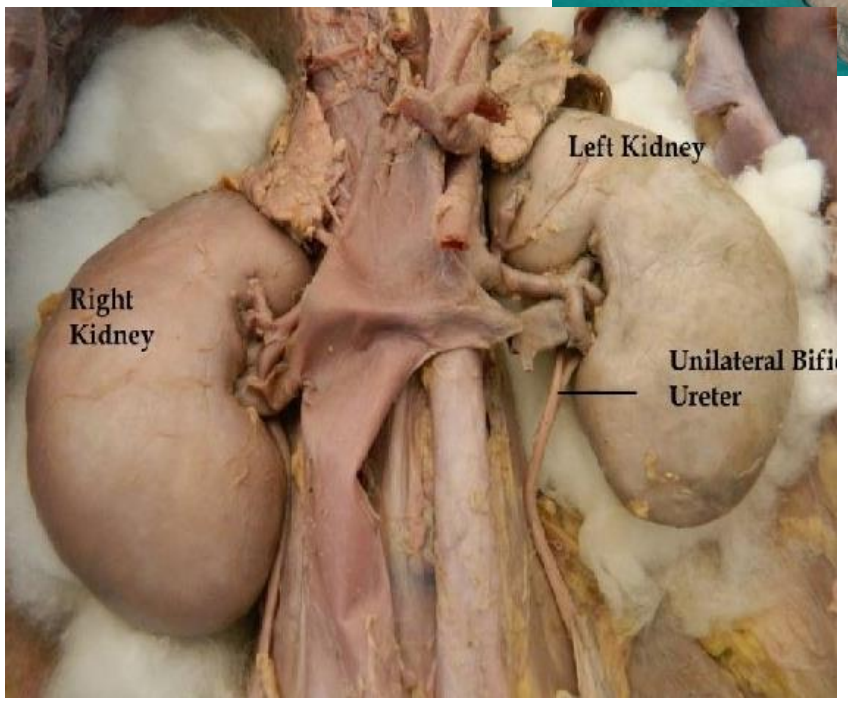
Congenital Anomalies of Ureter

1-Double ureters: Double ureteric buds.

2-Bifid ureter& cleft pelvis: Splitting of ureteric bud.

3- Absent ureter: No bud with renal agenesis.

4-Ectopic ureter: It opens into vagina or urethra.



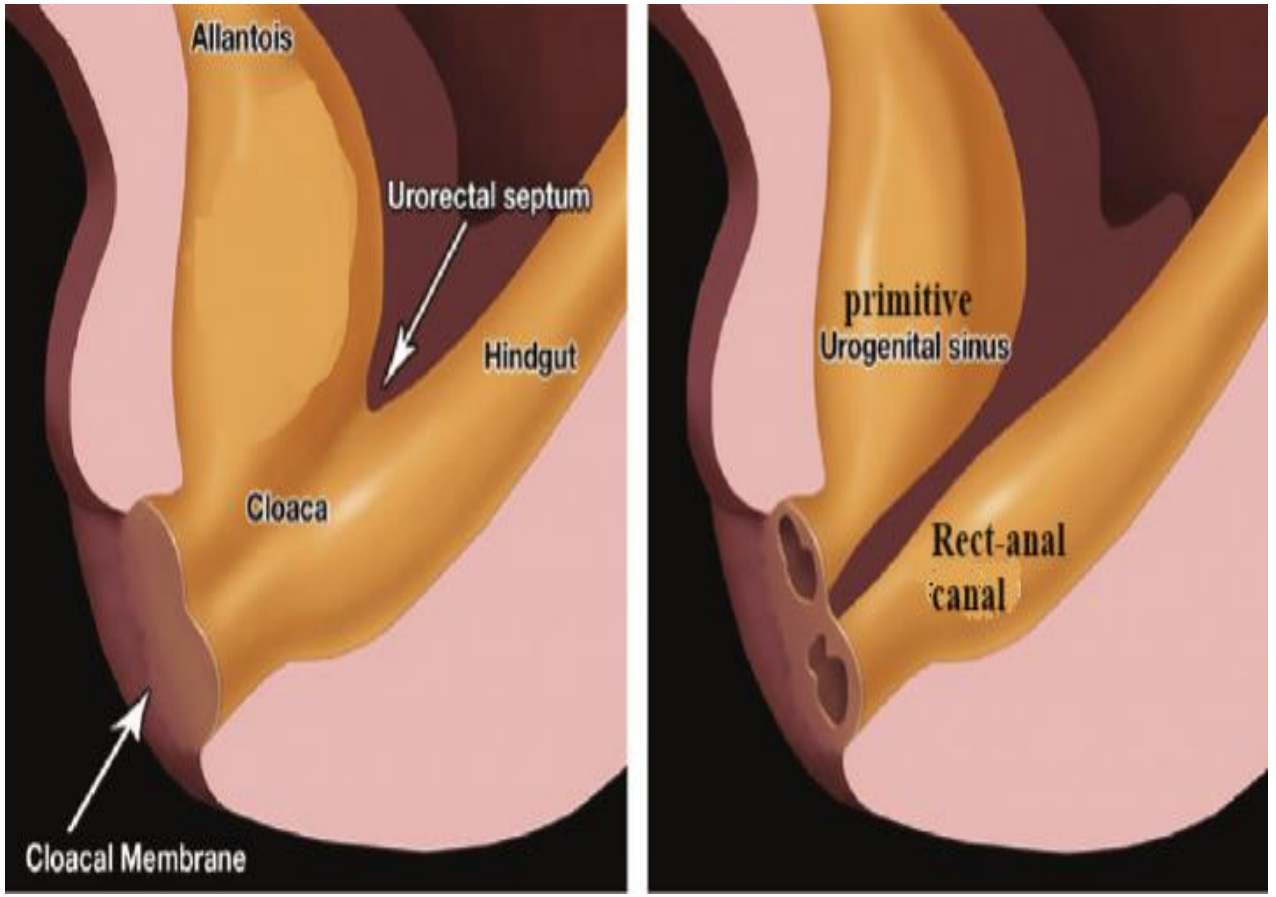
Cloaca and its Division

❑**The caudal part of the hindgut is expanded to form** the **Cloaca** (Endoderm).

❑**The cloaca is subdivided by the urorectal septum into:**

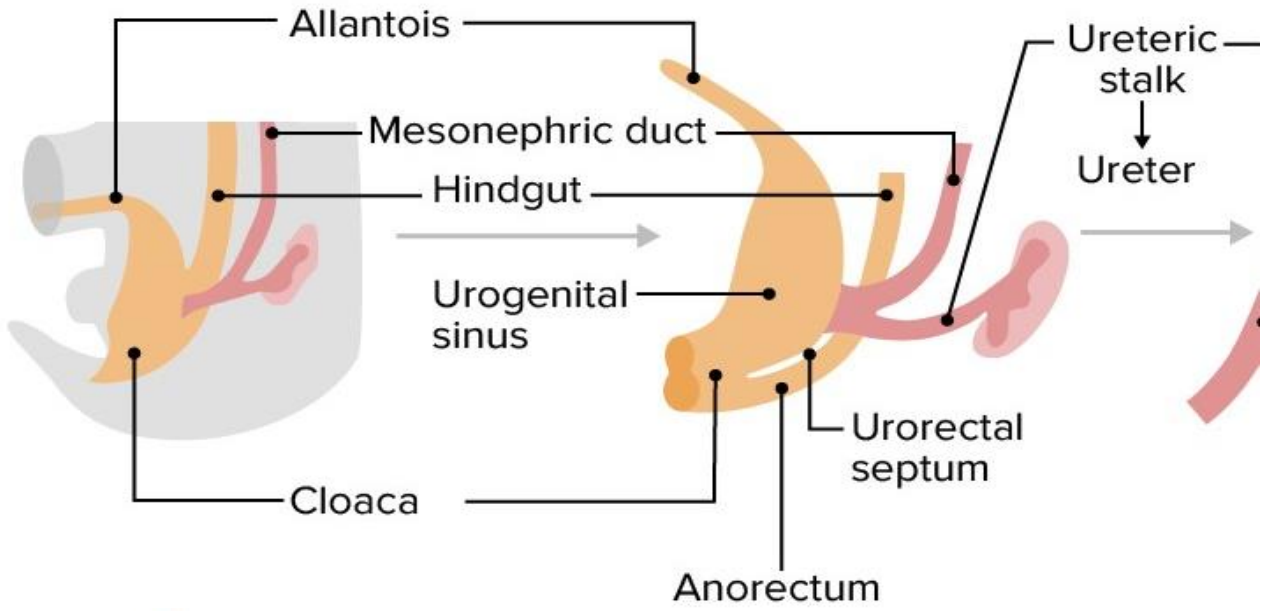
a) Dorsal portion termed the **Recto-anal canal.**

b)Ventral portion termed the **Primitive urogenital sinus.**



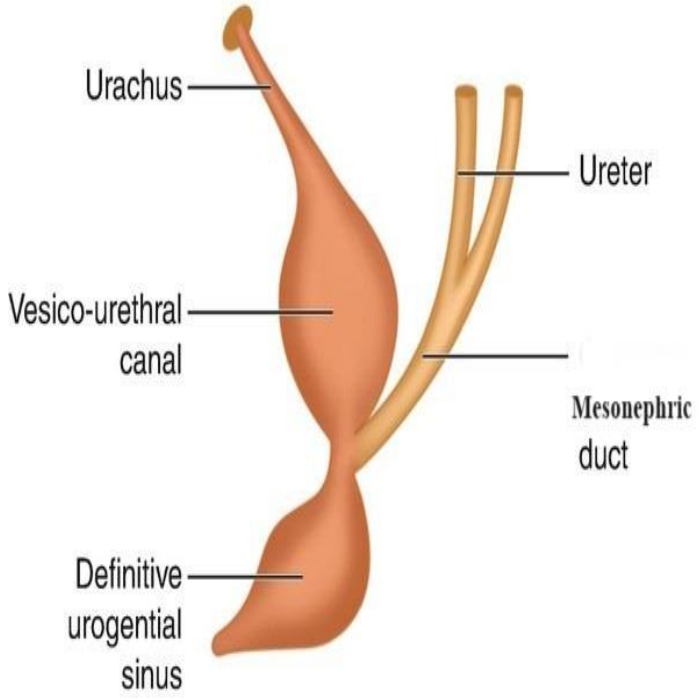
❑Primitive urogenital sinus:

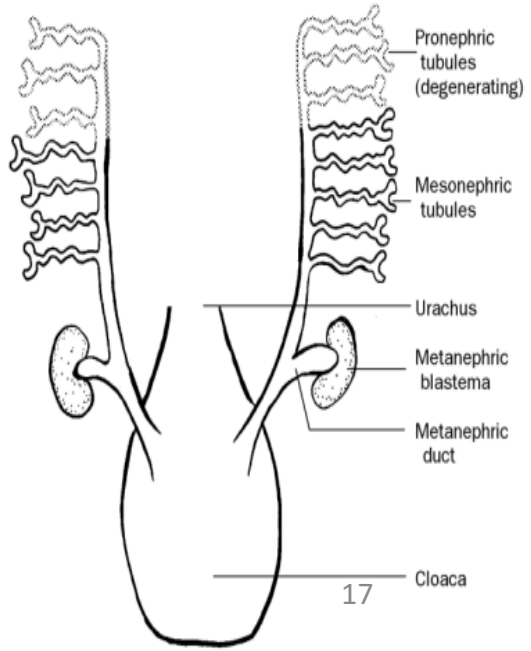
- **It receives** the opening of two mesonephric ducts and allantois at its apex.



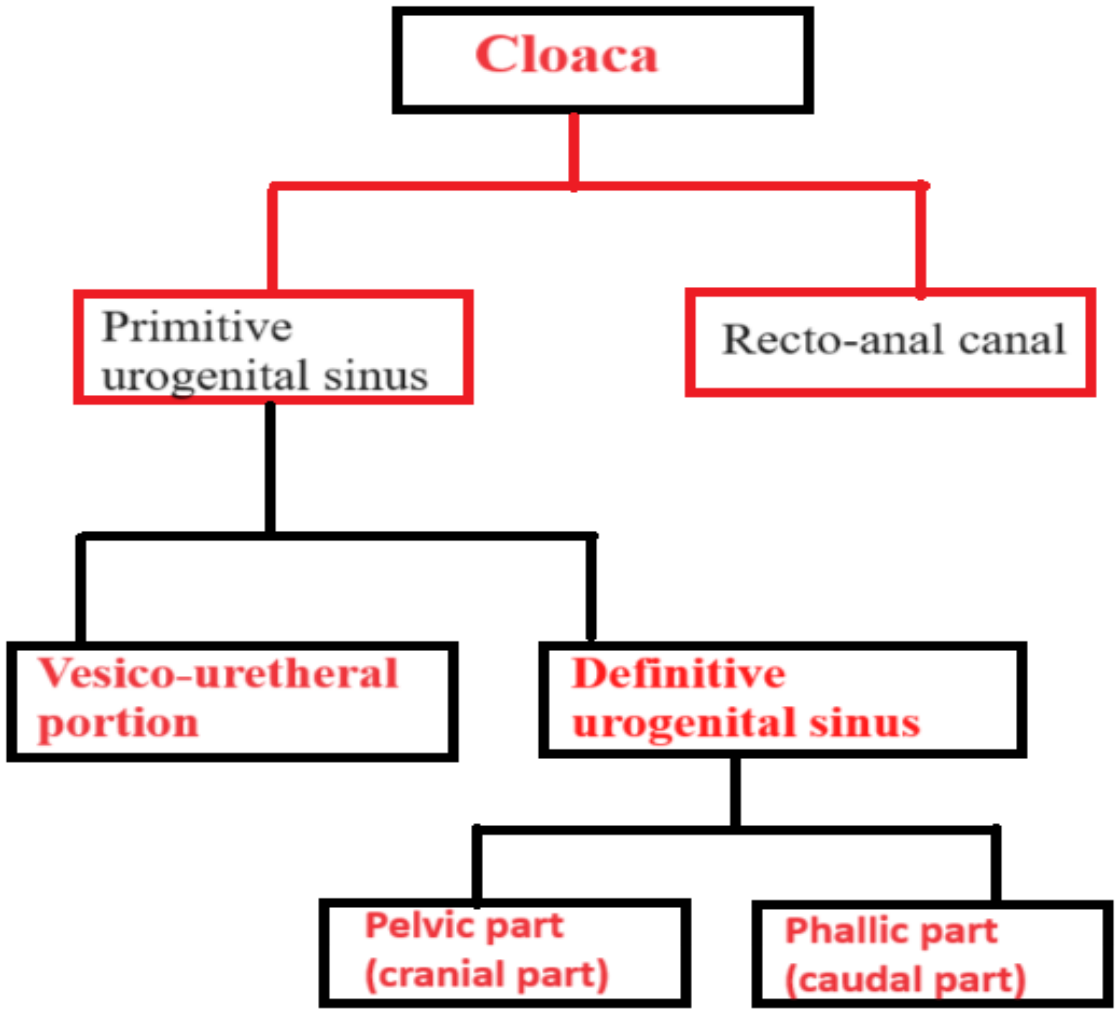
Primitive urogenital sinus divided into:

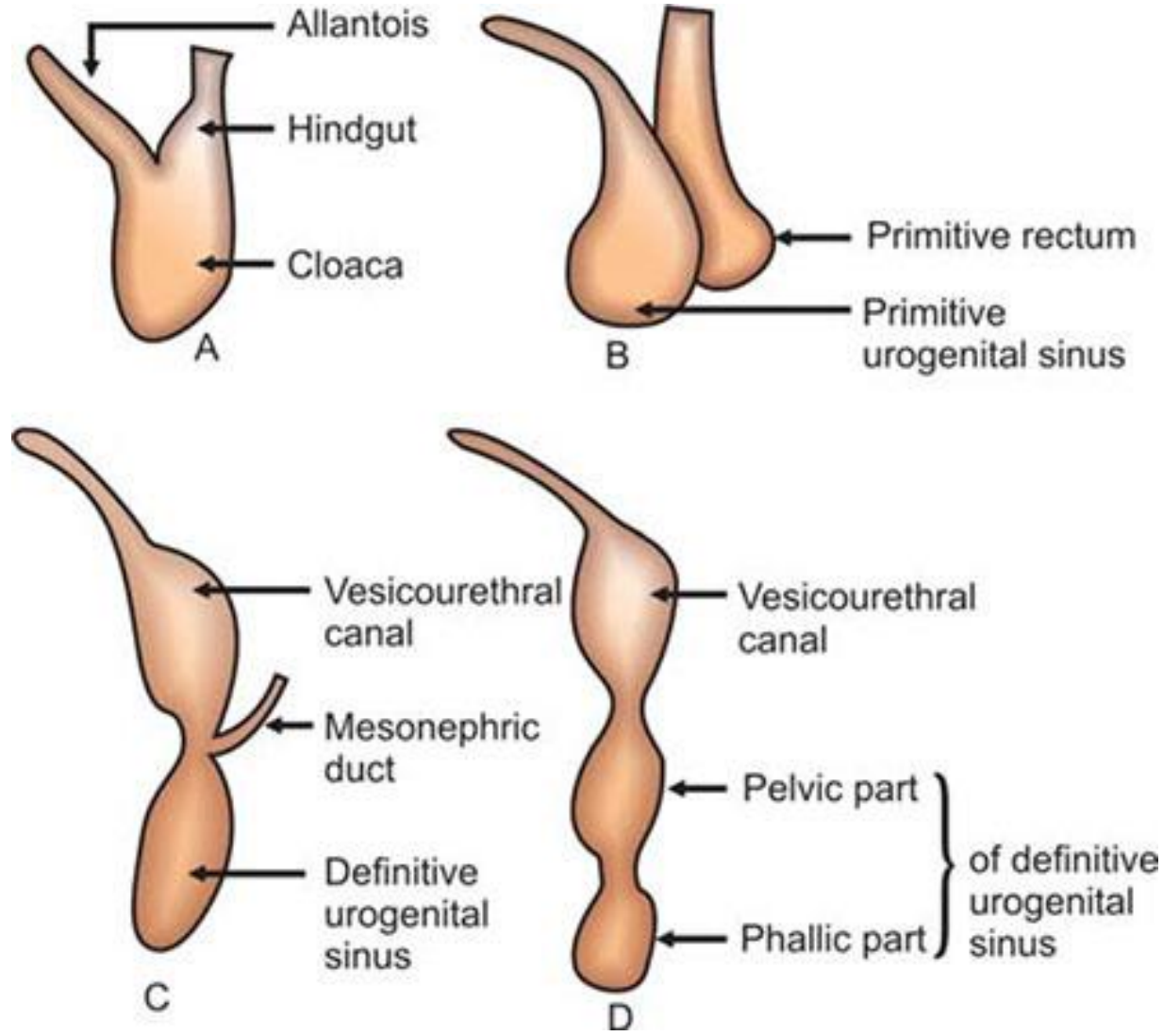
1) a cranial **Vesicouretheral portion.**
2) a caudal **Definitive urogenital sinus.**





Cloaca and its division





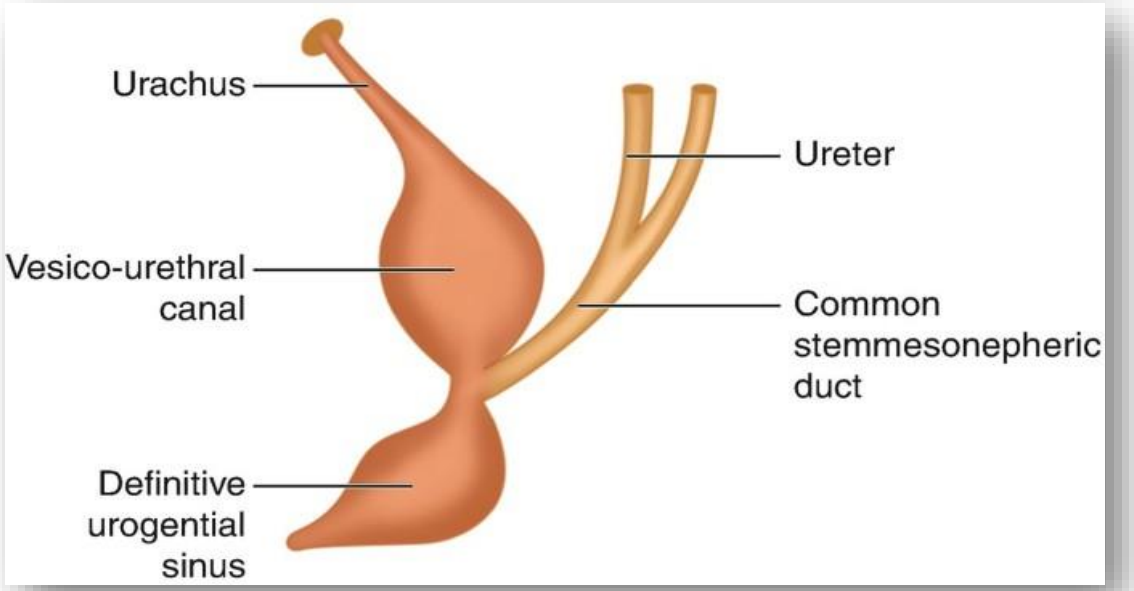
Development of Urinary Bladder

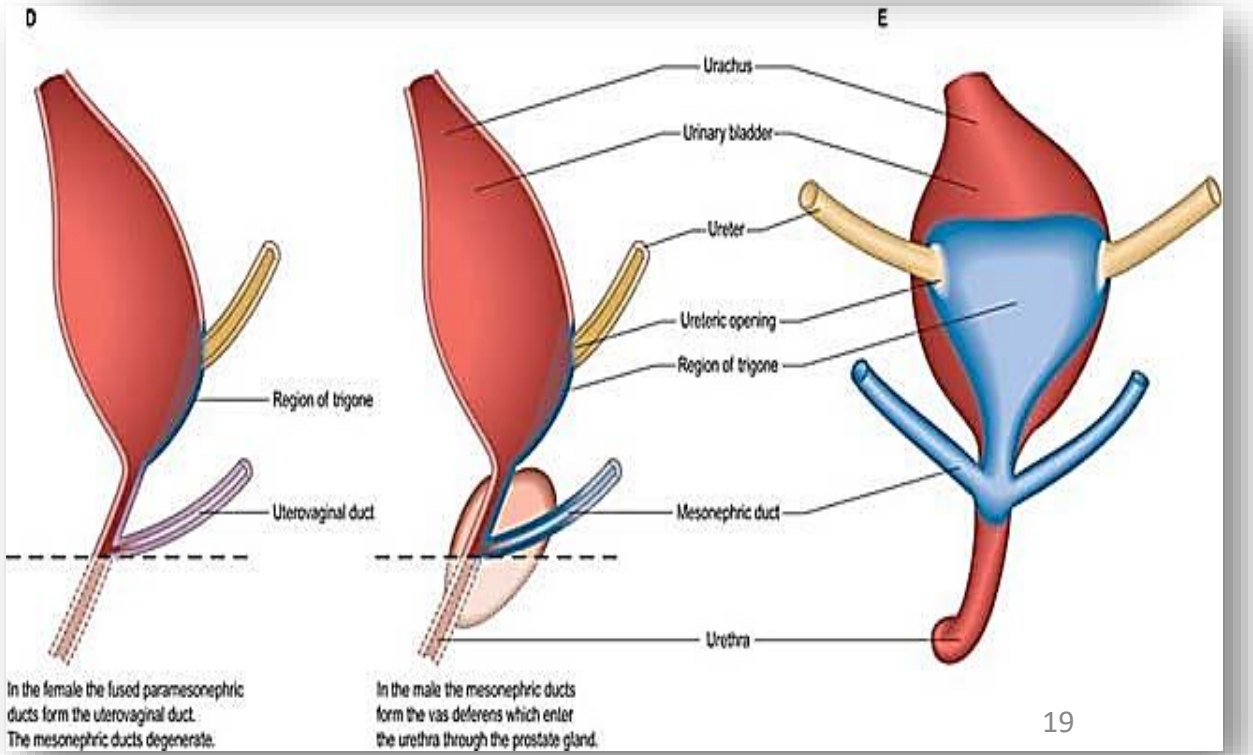
Mucosa develops from the following sources;

- Mainly from **Vesico-uretheral portion of cloaca** (**endoderm**).
- Proximal part of **allantois** (endoderm).
- Two caudal part of **mesonephric ducts** (mesoderm) give rise to **trigone**.
- The caudal part of mesonepheric ducts absorbed into bladder wall to form trigone of urinary bladder.

Other layers develop from;

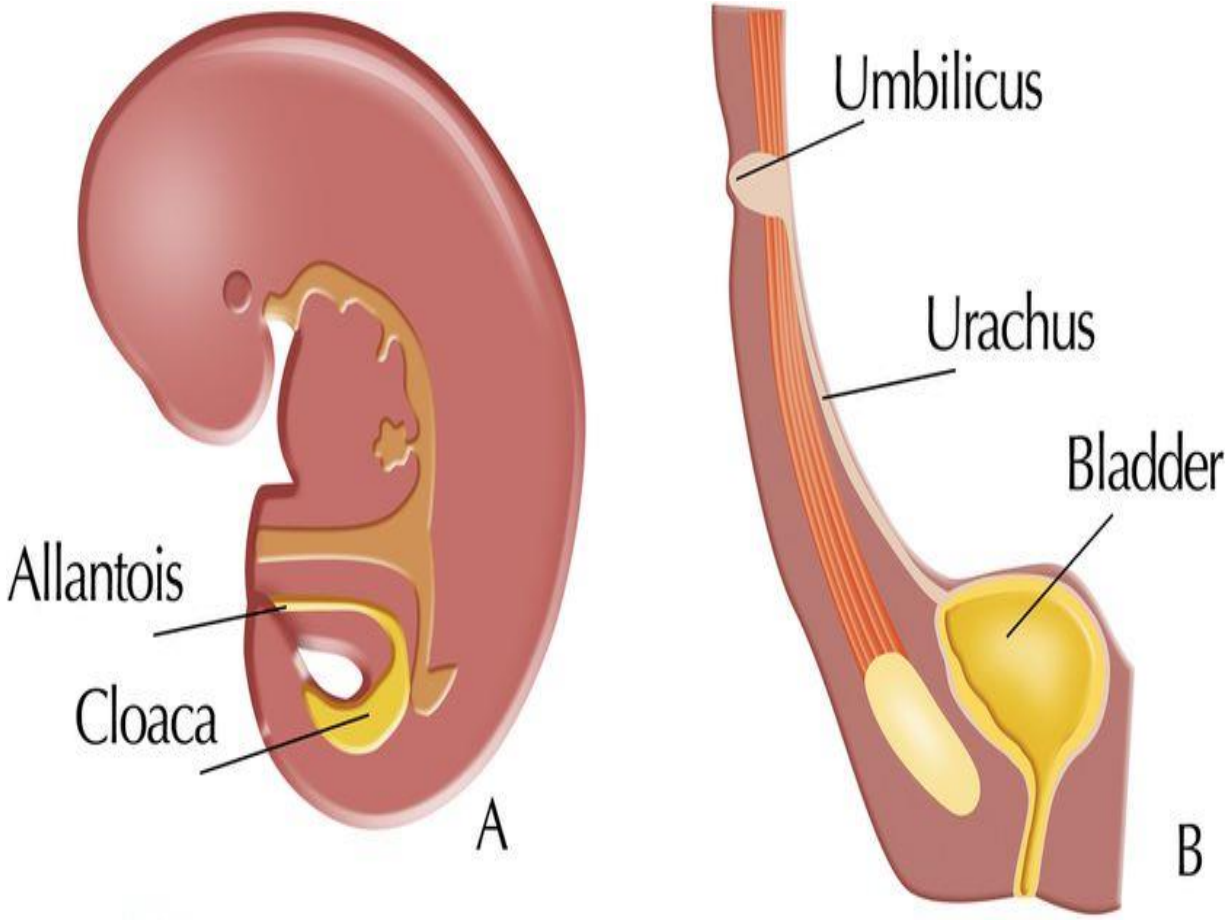
- Adjacent **splanchnic mesoderm** (mesoderm).





- Remaining un absorbed part of allantois is called **Urachus**.

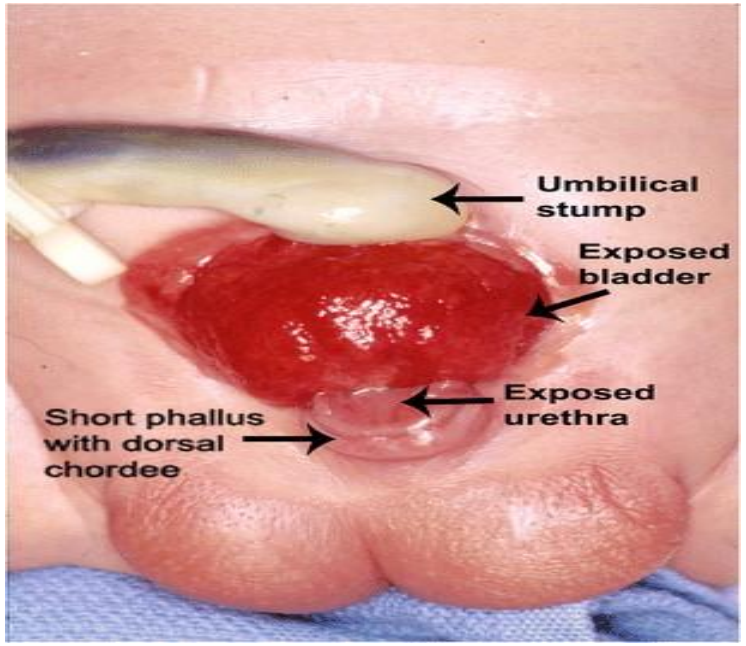
- After birth, urachus becomes completely obliterated and forms **Median Umbilical Ligament** that passes from bladder apex to the umbilicus.



Congenital Anomalies of Urinary Bladder

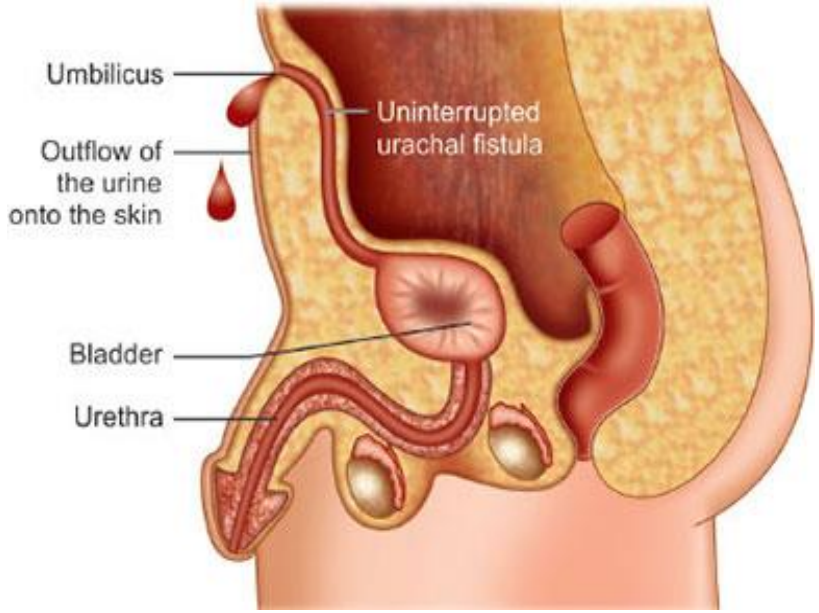
1-Ectopia vesica:

- The mesoderm fails to form the musculature of the infraumbilical region of anterior abdominal wall and anterior wall of urinary bladder.
- This is associated with exposure of the urinary bladder mucosa to the outside.



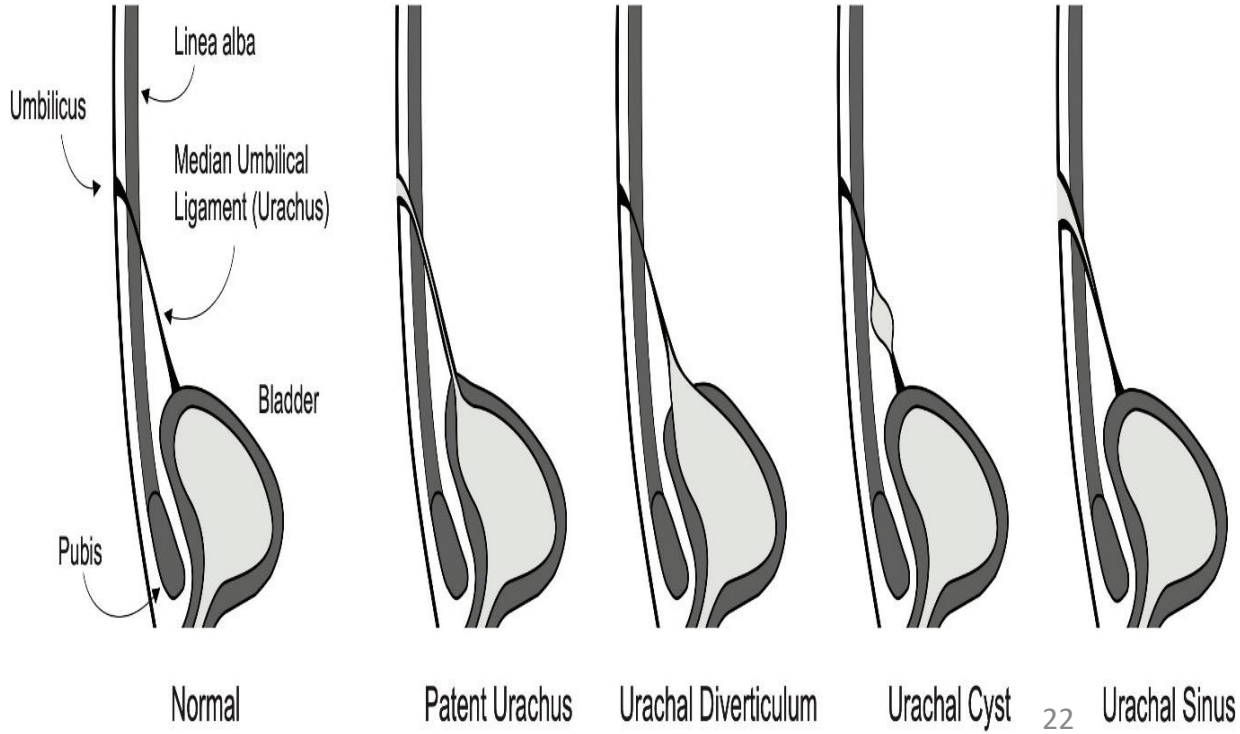
2- Anomalies of Urachus:

a) Urachal fistula: The entire urachus remains patent with subsequent discharge of urine through the umbilicus.



b) Urachal cyst: Only isolated part of the urachus fails to obliterate, the lining epithelium secret fluid.

c) Urachal sinus: Distal part of the urachus remains patent.



Development of the Male Urethra

Prostatic urethra

It develops from the followings sources:

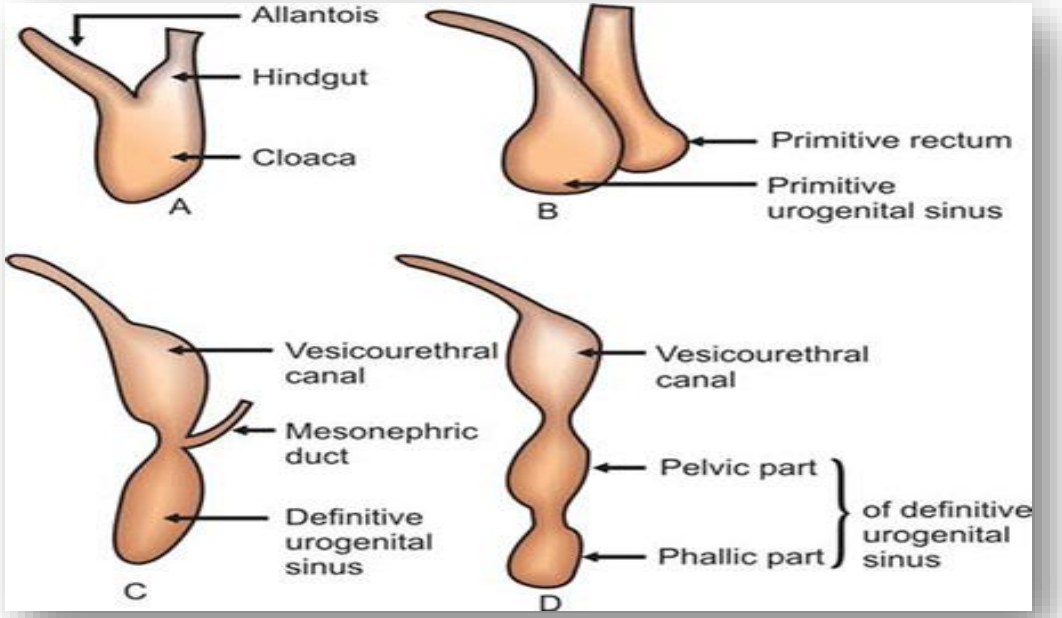
- **Vesico-urethral portion** (endoderm).
- **Absorbed part of mesonephric ducts** (mesoderm).
- **Definitive urogenital sinus** (pelvic portion) (endoderm).

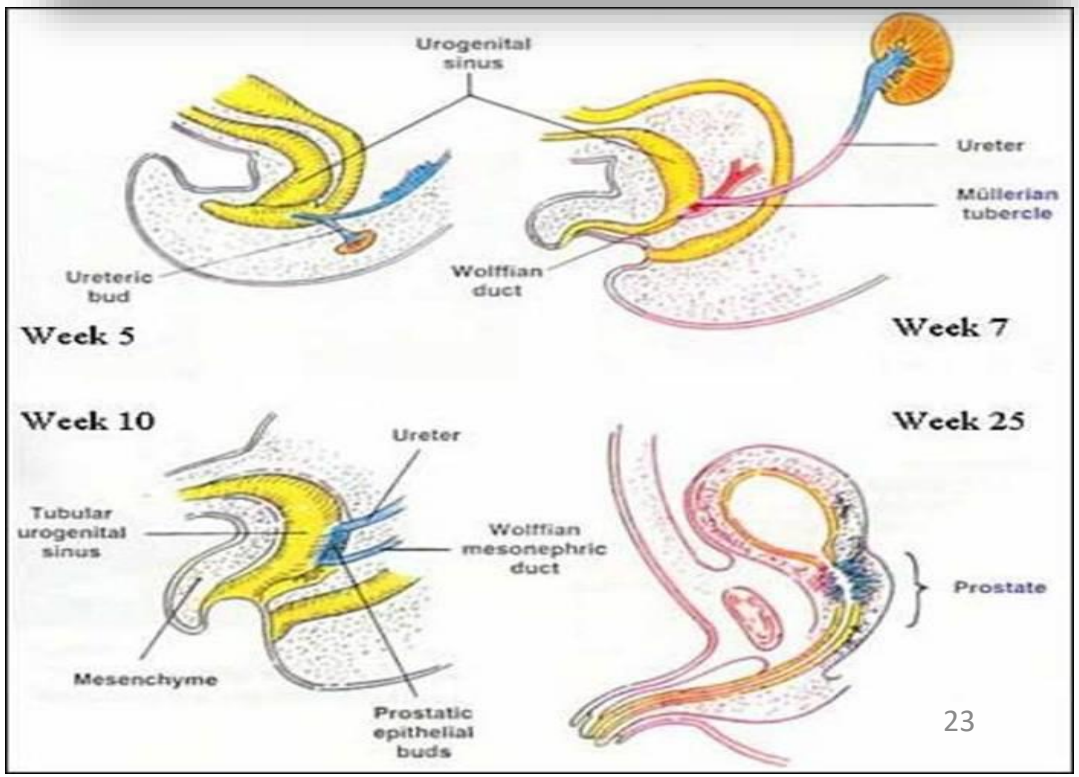
Membranous urethra:

- **Definitive urogenital sinus** (pelvic portion) **(**endodermal**)**.

Penile urethra:

- **Definitive urogenital sinus** (phallic portion) (endodemal**)**.
- Part of urethra inside glans penis from **migrating ectoderm cells** (ectodermal**)**.

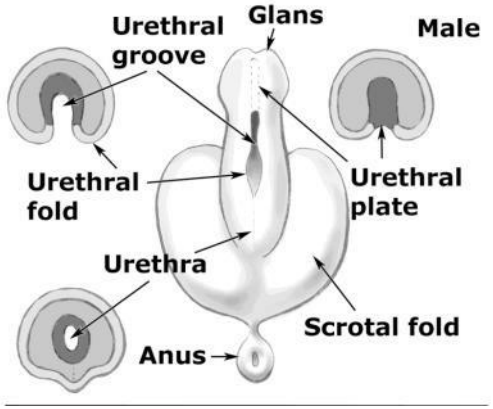




Steps of Development of Penile Urethra

1- Formation of urethral plate:

- The endoderm of the phallic portion of the definitive urogenital sinus proliferates, forming cord like a process **the urethral plate.**

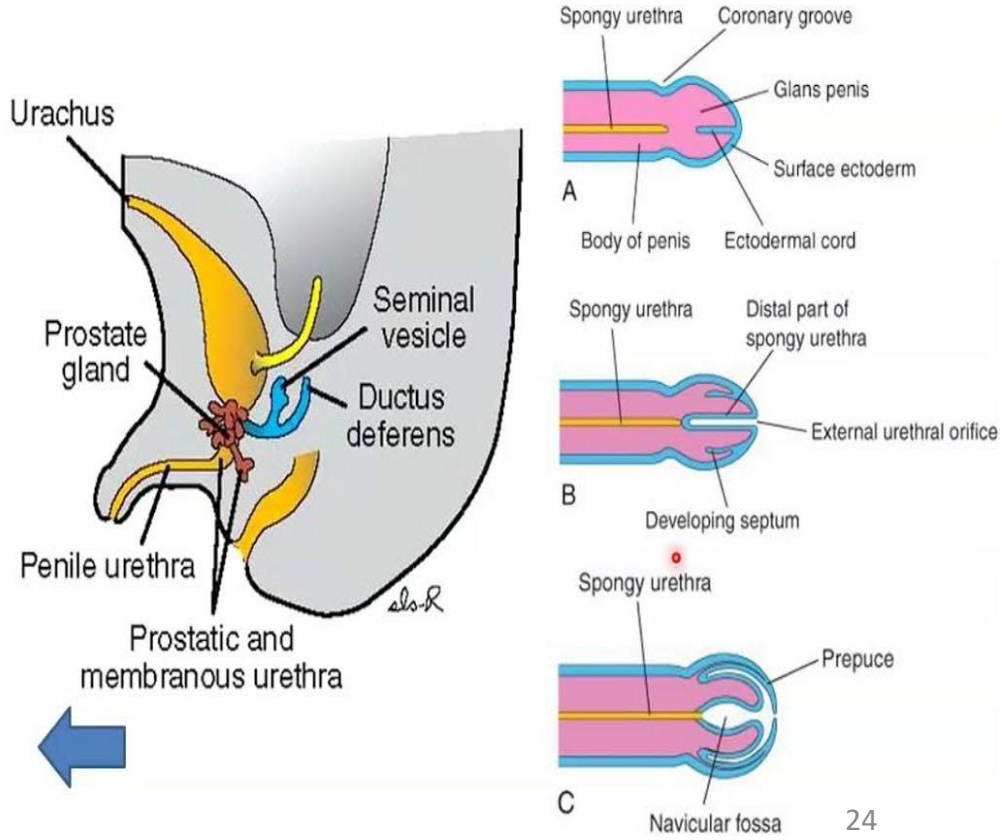


2. Formation of urethral groove:

- The **margins of the urethral groove are called urethral folds**. Which unite in the midline forming **urethral canal** (penile urethra).

3. Formation of part traversing glans penis:

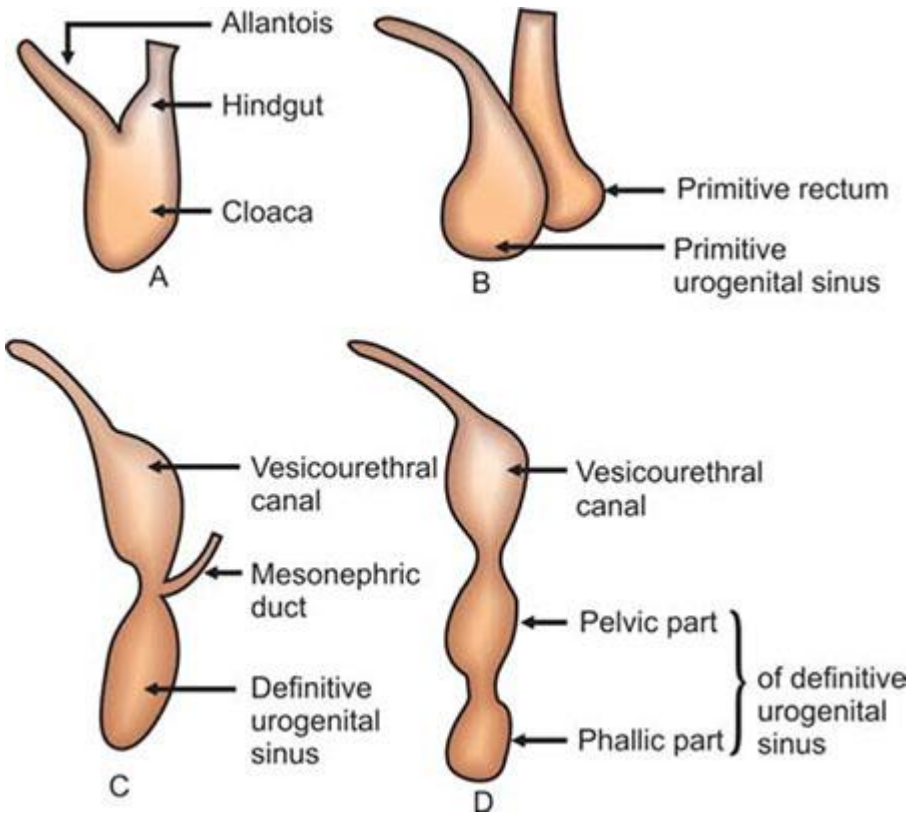
- A solid cord of ectodermal cells extends from the tip of the glans till it meets the endodermal penile urethra at the base of the glans. It is then canalized.



Development of Female Urethra

Developmental sources:

- **Vesico-urethral canal** (mainly).
- **Definitive urogenital sinus**.



Congenital Anomalies of Urethra

1- Hypospadius:

- In this anomaly **the urethra opens on the under surface of penis** due to failure of closure of edges of urethral groove. Its incidence 3-5/1000 births.

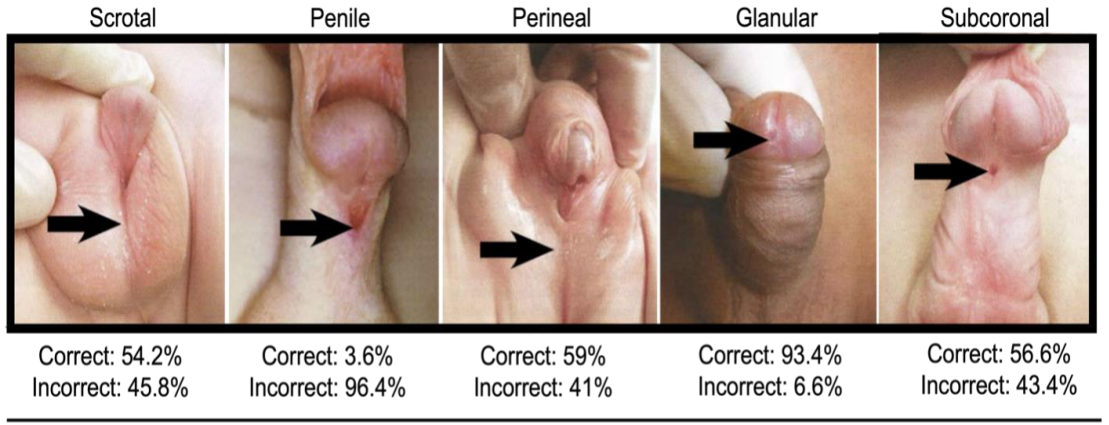


Figure 1. CDC atlas of hypospadias classification and percentages of correct answers by survey responses

2- Epispadius:

- In this condition, **the urethra opens into the dorsum of the penis**. Its incidence 1/30 000 births.

3- Urethral stenosis:

- **Due to** incomplete canalization of the part within glans penis, or excessive fusion of edges of urethral groove.


Thank You!