

# Development of the Urinary System



**Dr. Ahmed Salman**

Associate professor of anatomy & embryology



# Development of The kidney

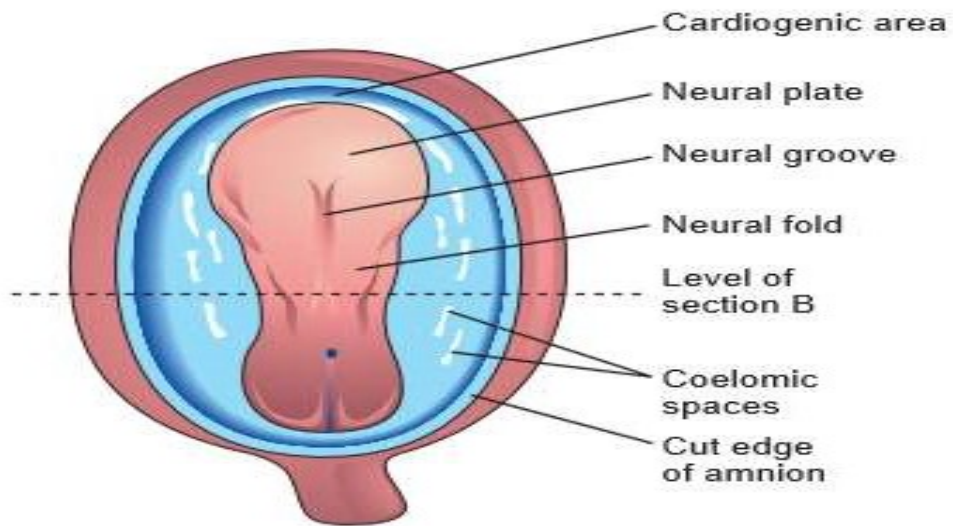
Dr Ahmed Salman



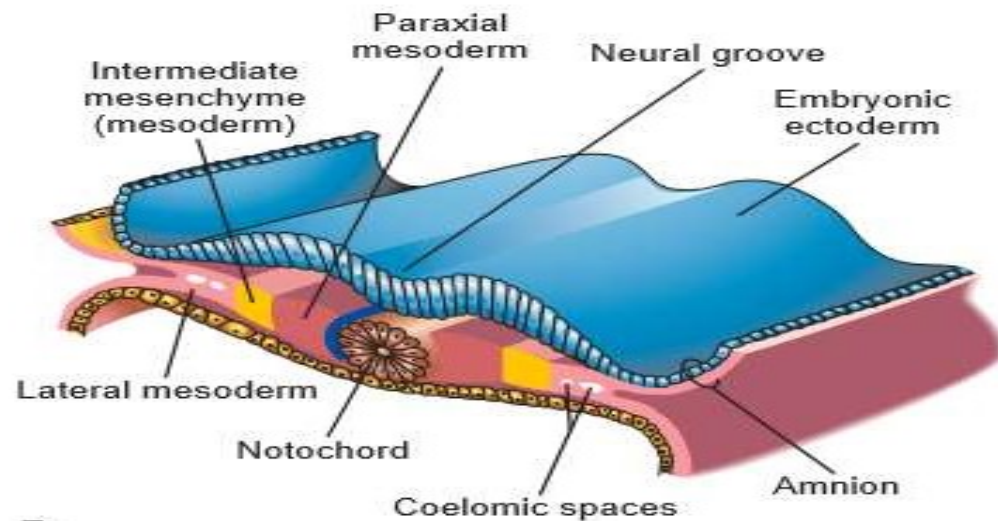
## Development of the upper urinary system

It is developed from the intraembryonic intermediate mesoderm.

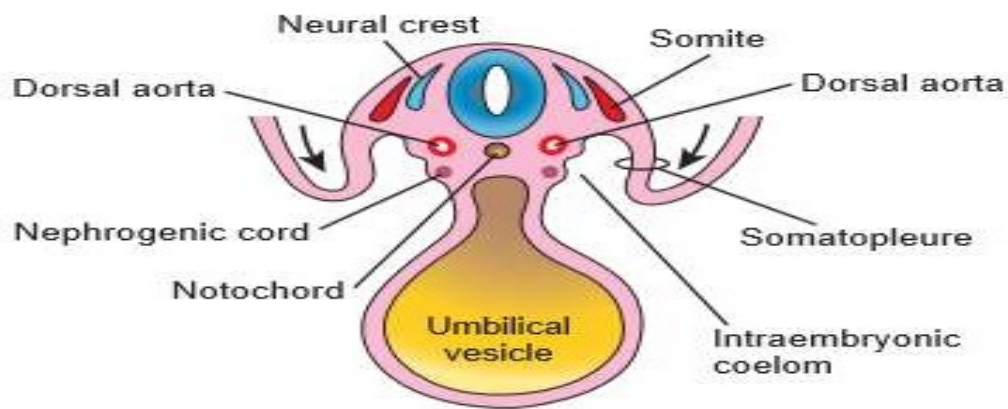
- After folding of the embryo, this mesoderm lies behind the intraembryonic coelom on each side of the descending aorta.
- The kidney development passes in **three** successive stages :
  1. Pronephros.
  2. Mesonephros.
  3. Metanephros.



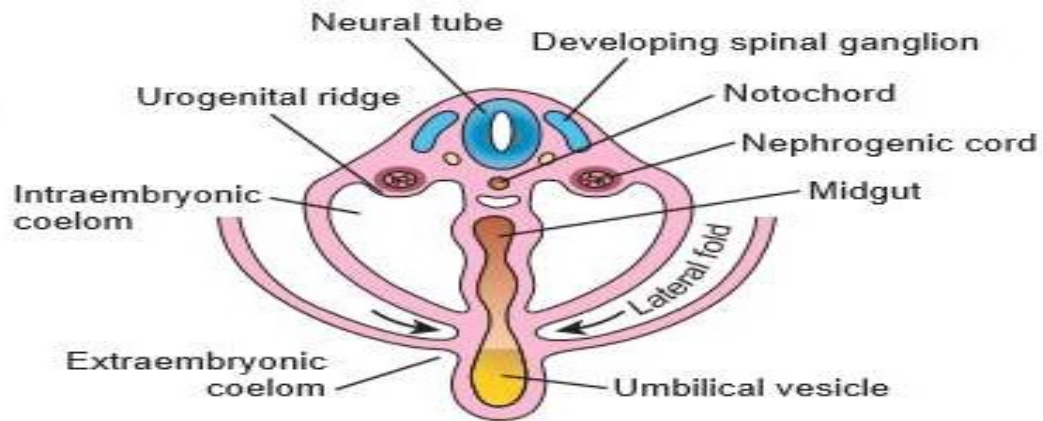
A



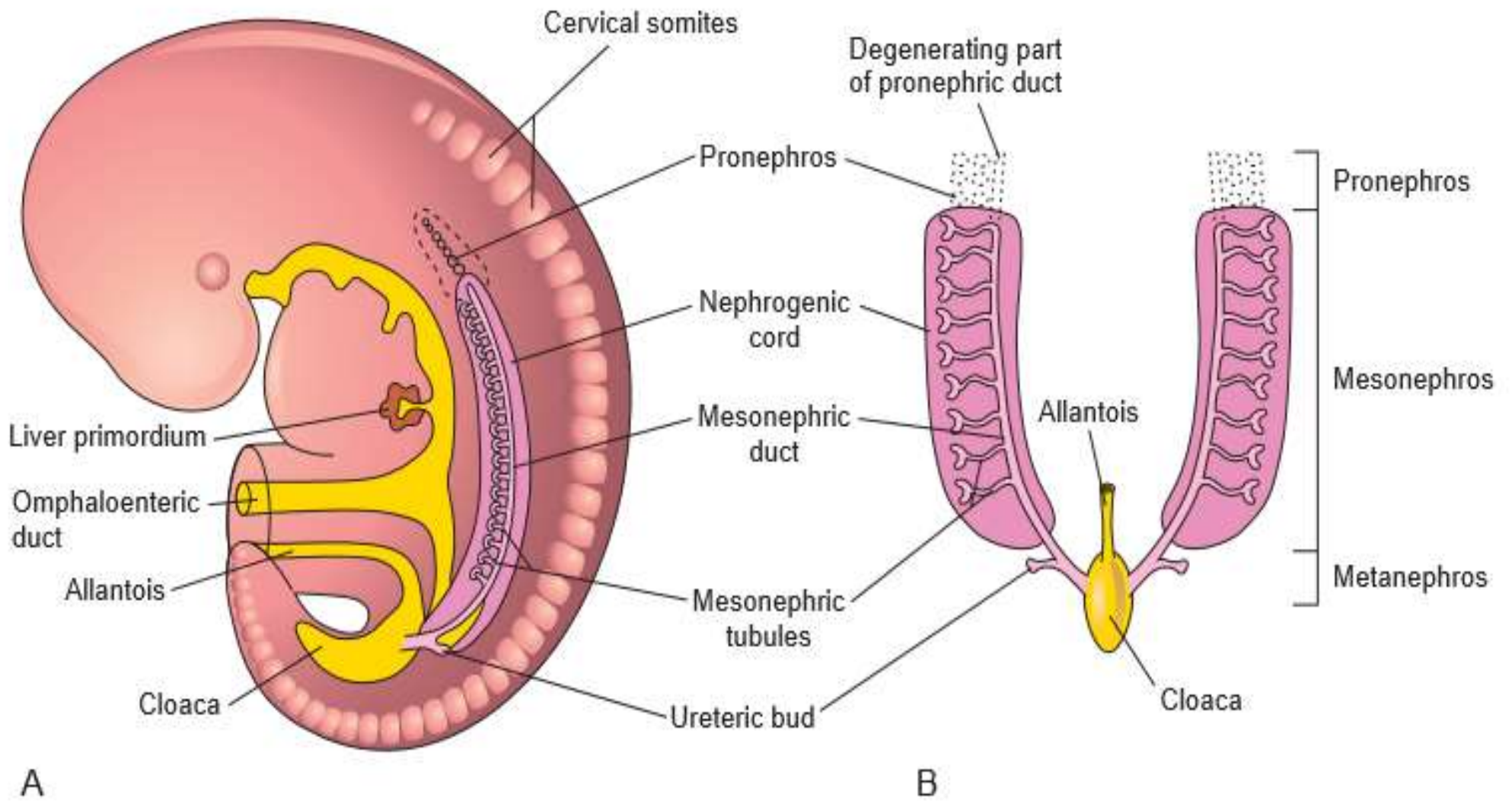
B



C



D



## The Pronephros

It develops from the intermediate mesoderm of the **cervical region** the embryo at **4th week**

- The intermediate mesoderm is segmented into 7 cell clusters called nephrotomes.
- The nephrotomes elongate and become canalized to form pronephros tubules.
- Each tubule has **two** ends:
  - **Medial end** receives a capillary plexus from the adjacent aorta, forming an internal glomerulus
  - **Lateral end** grows in a caudal direction and unites with the succeed tubules to form the pronephric duct, which descends to open in cloaca.

### Fate of the pronephros:

- The pronephric tubules degenerate.
- The pronephric duct is transformed into the mesonephric duct, serves the second kidney

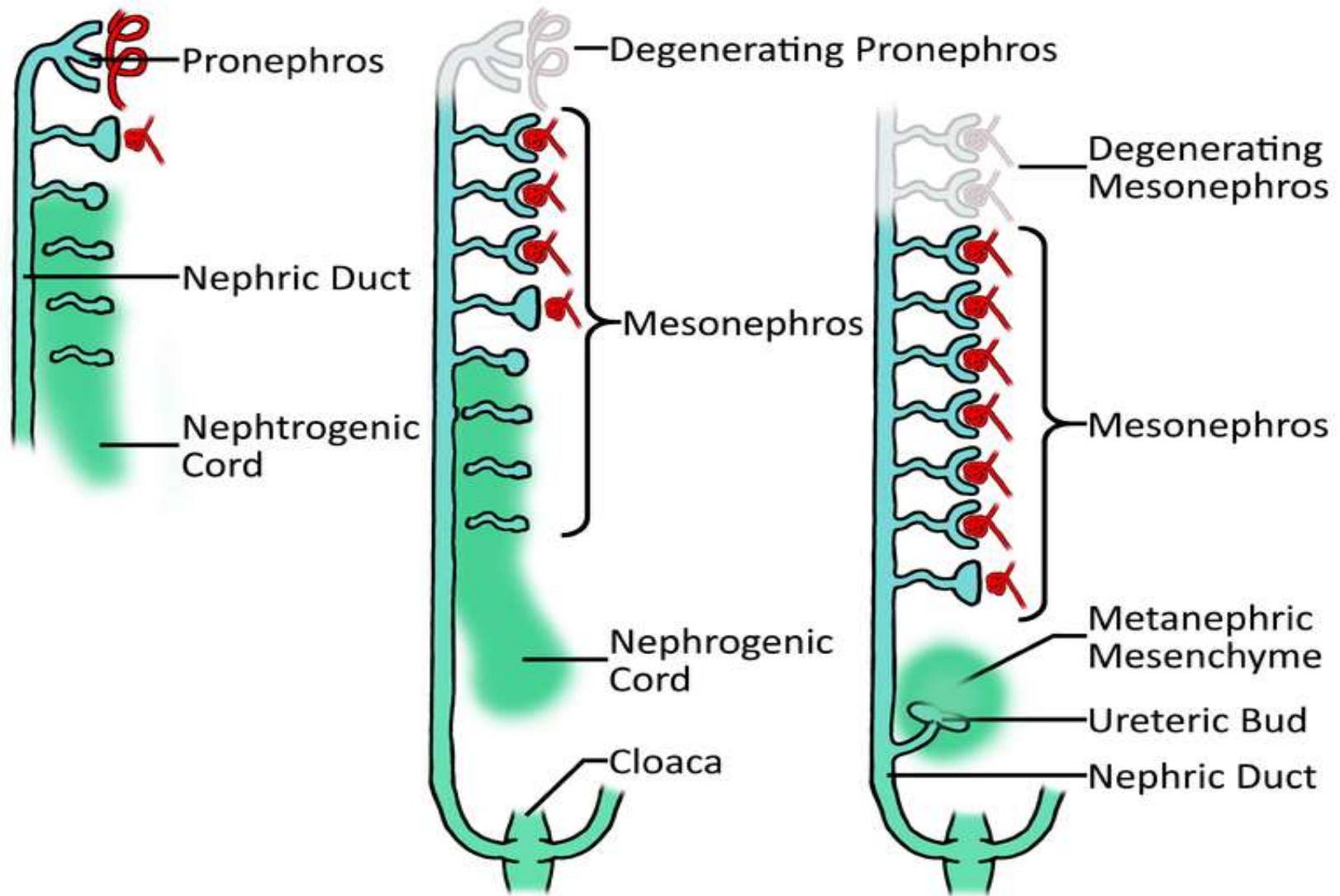
## The mesonephros

It develops from the intermediate mesoderm of the **thoracic and upper lumbar** regions.

Development:

- The intermediate mesoderm is segmented into about 70 clusters.
- These clusters elongate and become canalized to form S- shaped mesonephric tubules.
- Each tubule has *two* ends:
  - **Medial end** is invaginated by a capillary plexus to form a primitive glomerulus. Around the glomerulus the tubules form **Bowman's capsule**, and together these structures constitute a **renal corpuscle**
  - **Lateral end** joins the mesonephric duct or **wolffian duct**







## **Fate of the mesonephros:**

-The mesonephros degenerates and is replaced by the metanephros (permanent kidney).

- However, parts of the mesonephros persist to form urogenital structure which differ in male and female.

### **1. The mesonephric tubules form :**

<b>Male</b>	<b>Female</b>
Efferent ductules of the testis Head of epididymis Paradidymis	Epoophorn paroophoron

## 2. Mesonephric ducts In the MALE form

Genital structures	Urinary structures
<ul style="list-style-type: none"><li>- Body and tail of epididymis and its appendix</li><li>- Vas deferens</li><li>- Seminal vesicle.</li><li>- Ejaculatory duct</li></ul>	<ul style="list-style-type: none"><li>- Ureteric bud and its derivatives (ureter, renal pelvis, calyces and collecting tubules)</li><li>- Trigone of the urinary bladder</li><li>- <u>Posterior wall of the supra collicular part of the prostatic urethra</u></li></ul>

## 2. Mesonephric ducts In the FEMALE form

Genital structures	Urinary structures
<ul style="list-style-type: none"><li>- Duct of epoophorn.</li><li>- Gartner's duct.</li></ul>	<ul style="list-style-type: none"><li>- Ureteric bud and its derivatives (ureter, renal pelvis, calyces and collecting tubules).</li><li>- Trigone of the urinary bladder.</li><li>- <u>The whole dorsal wall of the female urethra.</u></li></ul>

## Metanephros

**Site:** in the **sacral** region **at 5<sup>th</sup> month** of development

It develops from **two** mesodermal structures, ureteric bud and Metanephric cap.

### A. The ureteric bud.

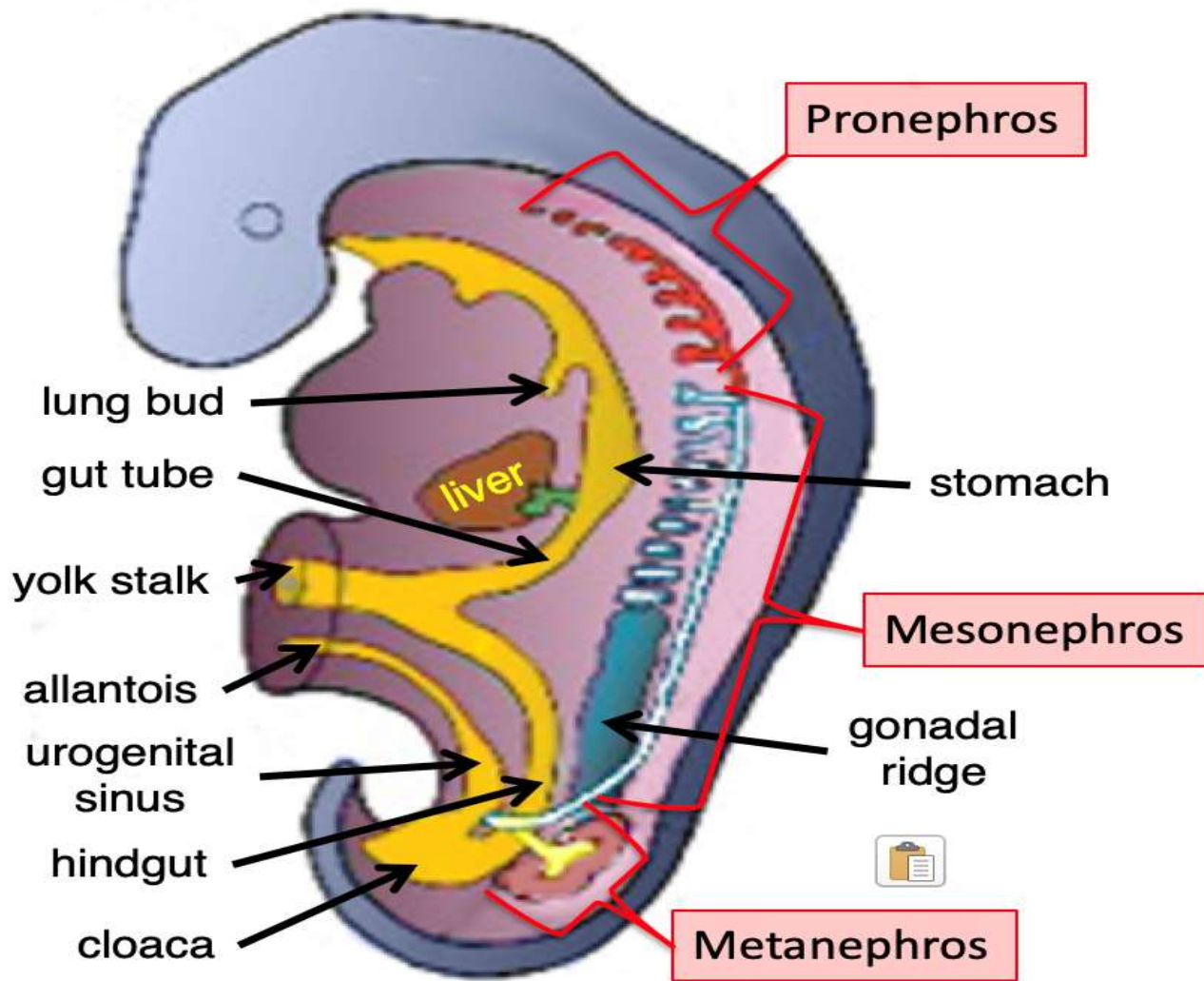
It arises as a diverticulum from the lower part of the mesonephric duct near the cloaca.

The bud gives rise to the collecting system of urine:

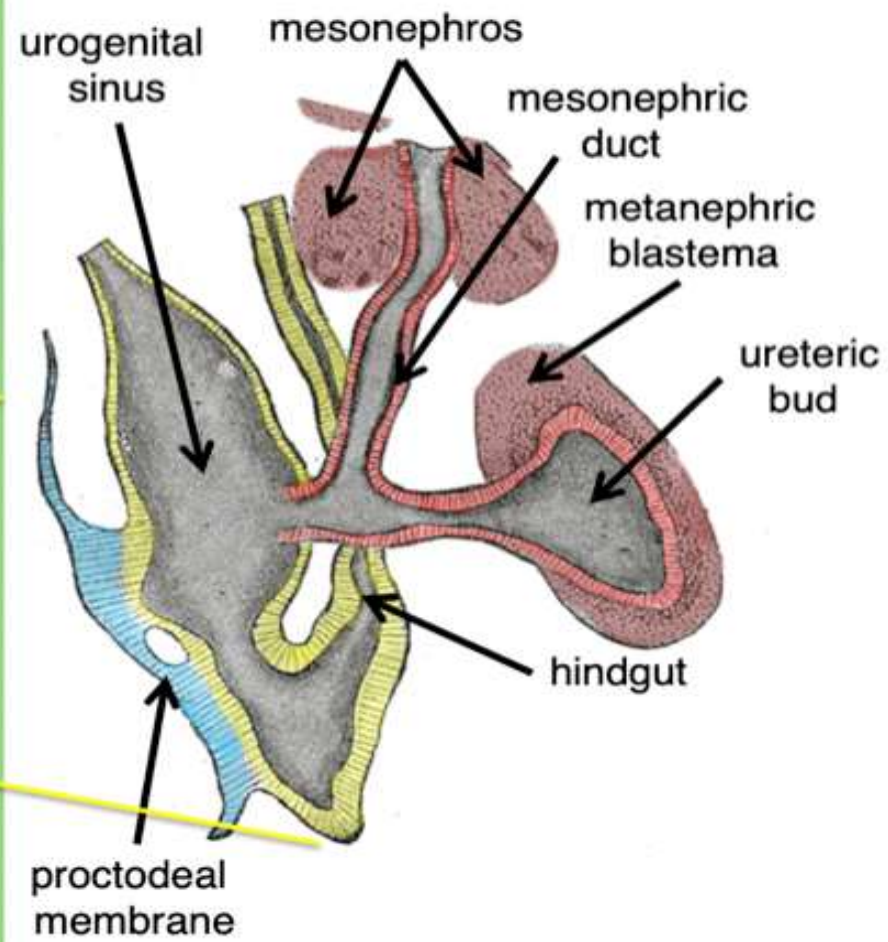
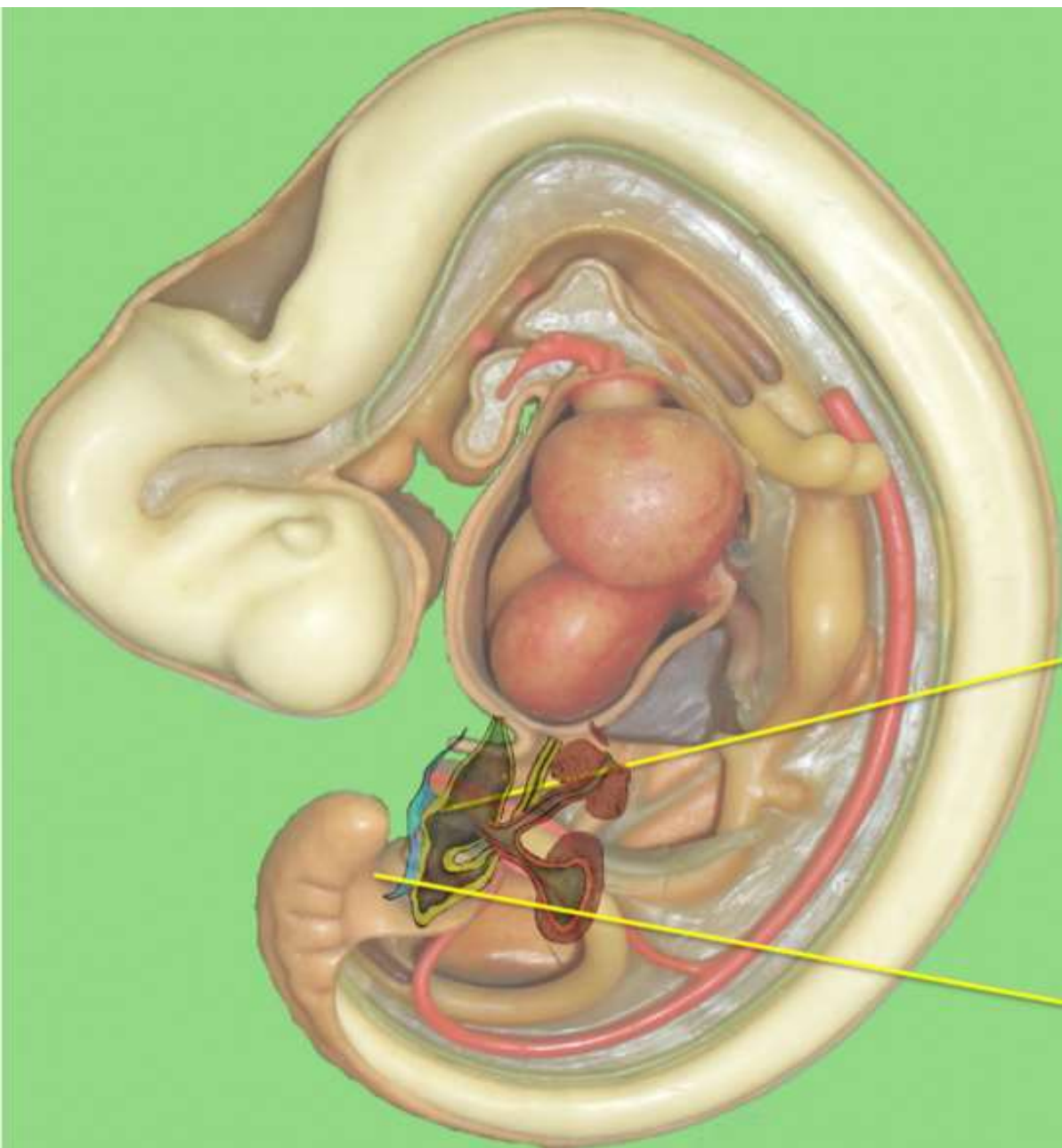
- ❖ Ureter from its stem.
- ❖ Renal pelvis from its cranial end which divides to form 2 calyces which in turn divide to form 7-11 minor calyces.
- ❖ Collecting tubules.

## B. Metanephric cap

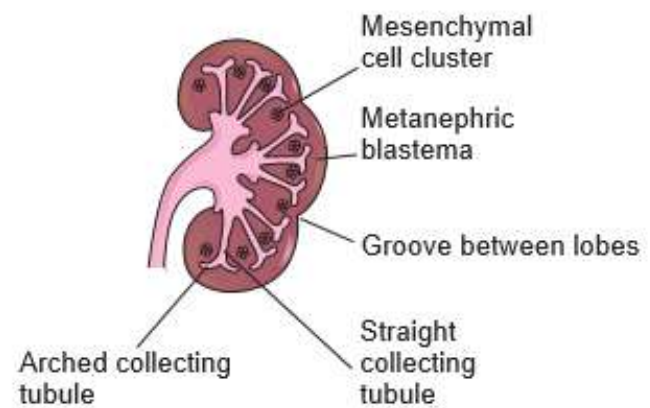
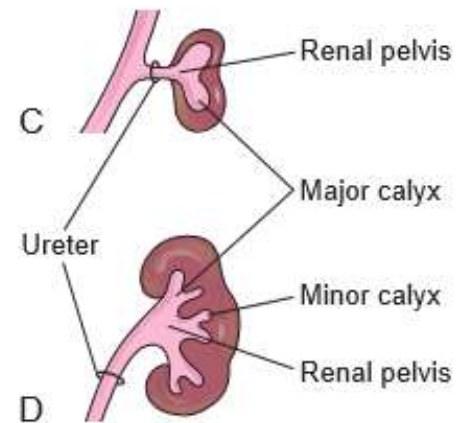
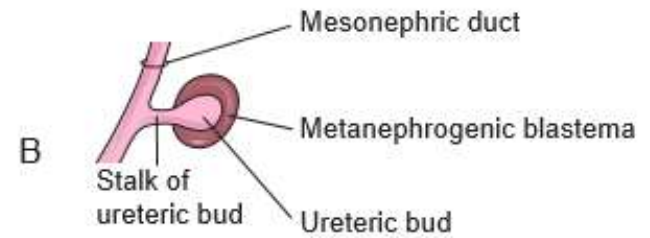
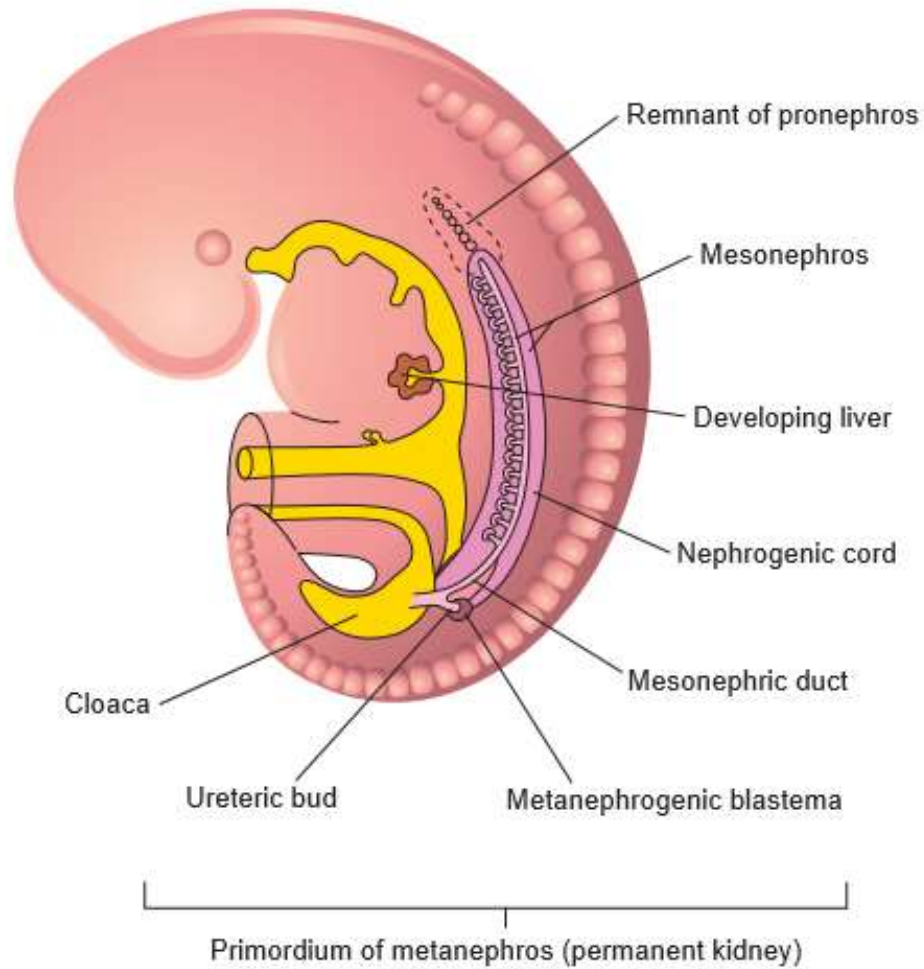
- It is the caudal part of the intermediate mesoderm.
- This mesoderm (is induced by the ureteric bud) to divide into thousands of cell clusters which lie close to the collecting tubules of the ureteric bud.
- The cell clusters elongate and become canalized to form renal vesicle which give rise to **nephrons**, which are the active excretory units of the kidney.
- **Each nephron gives rise to:**
  - Bowman's capsule which receives an afferent arteriole to form glomerulus.  
The capsule and the glomerulus constitute together a renal corpuscle.
  - Proximal convoluted tubule.
  - Loop of Henle.
  - Distal convoluted tubule, which joins a nearby collecting tubule to form a complete functional unit.



5 Week Embryo







## Postnatal changes in the metanephros :

**1. Change in shape:** the fetal kidney is lobulated with irregular surface.

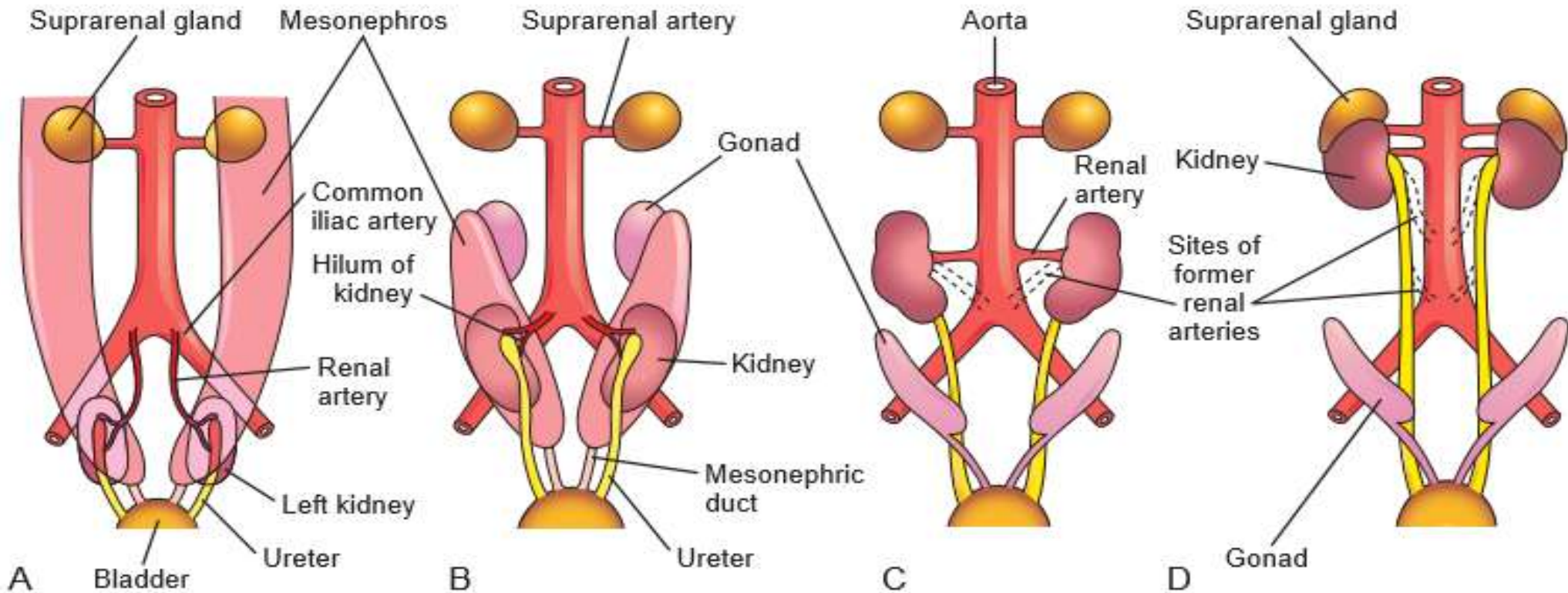
Lobulation disappears during early infancy.

**2. Change in position and blood supply:**

At first it is a pelvic organ, which receives its blood supply from the median sacral artery.

As it ascends into the abdomen, it changes its blood supply to be derived from the common iliac artery and finally from the abdominal aorta.

**3. Change in direction:** originally, the hilum of the kidney is directed *anteriorly* but with its ascent, the kidneys rotate medially almost 90 degrees the hilum rotates to face *medially*.



**Figure 13-7** **A to D**, Diagrammatic ventral views of the abdominopelvic region of embryos and fetuses (sixth to ninth weeks), showing medial rotation and relocation of the kidneys from the pelvis to the abdomen. **C** and **D**, Note that, as the kidneys relocate (ascend), they are supplied by arteries at successively higher levels and that the hila of the kidneys (where the vessels and nerves enter) are directed anteromedially.

## **Congenital anomalies**

**1- Renal agenesis** with absence of one or the two kidneys .

In this case the ureteric bud fails to induce the metanephric cap to divide

### **2. Congenital polycystic kidney**

- Cysts form from collecting ducts
- kidney shows many cysts filled with urine

**3. Ectopic kidney, (Pelvic Kidney)** in which case it fails to ascend.

### **4. Horse - shoe kidney**

- Two kidneys are fused at their lower poles.
- Ascent of the kidneys is prevented by the origin of the inferior mesenteric artery.

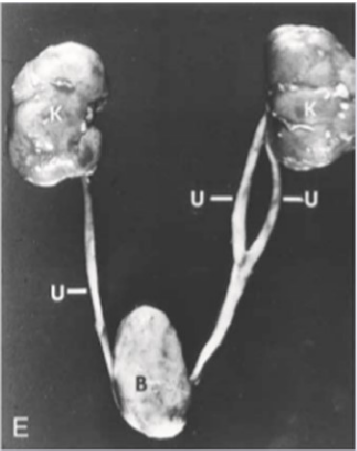
**5. Accessory renal artery:** an additional artery may enter the upper or lower pole of the kidney.

**6. Bifid ureter** is due to the bifurcation of the upper end of the ureteric bud with double renal pelvis.

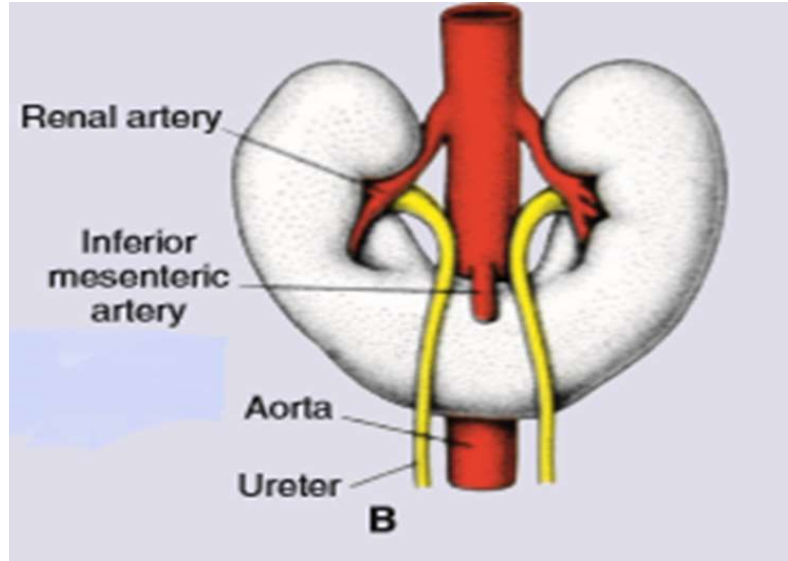
### **7. Double ureter duplication of the urinary tract**

Occurs when the ureteric bud prematurely divides before penetrating the metanephric cup Results in either a double kidney or duplicated ureter and renal pelvis

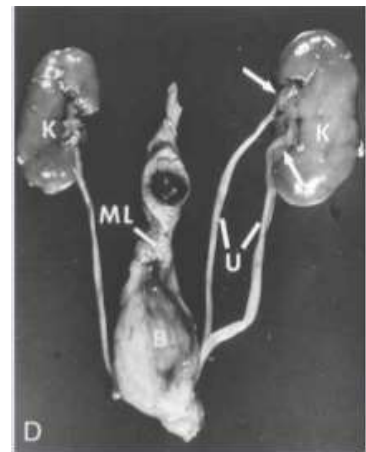
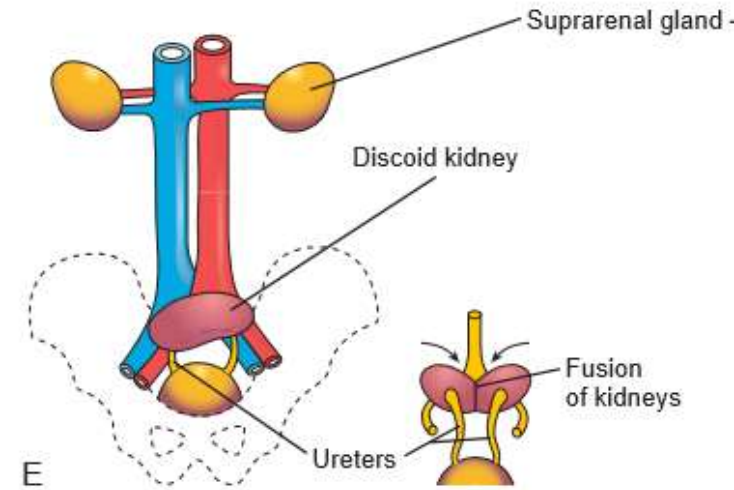




**Bifid ureter**



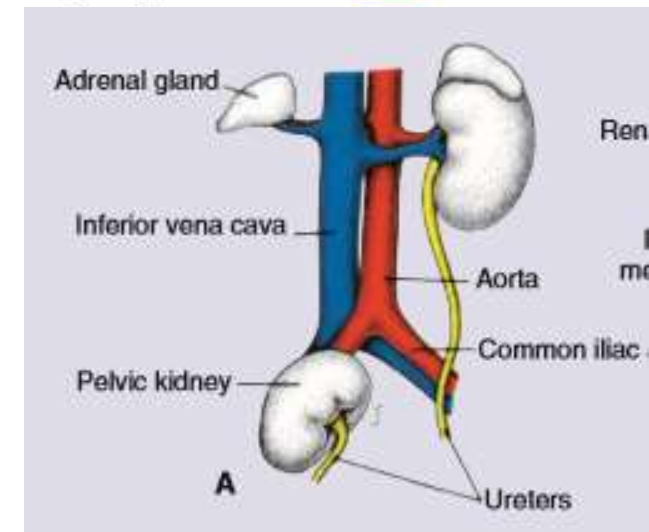
**Horseshoe kidney**



**duplication of the urinary tract**



**Congenital polycystic kidney**







# **Development of the urinary bladder**

Dr Ahmed Salman

## A. Development of the cloaca:

- The cloaca is a dilatation lined by endoderm at the terminal part of the Hindgut.
- The cloaca is
  - Ventrally it is continuous with the allantois.
  - Its sides receive the mesonephric ducts.
  - Caudally it is closed by cloacal membrane.
- A mesodermal urorectal septum descends between the allantois and hindgut to reach the cloacal membrane.

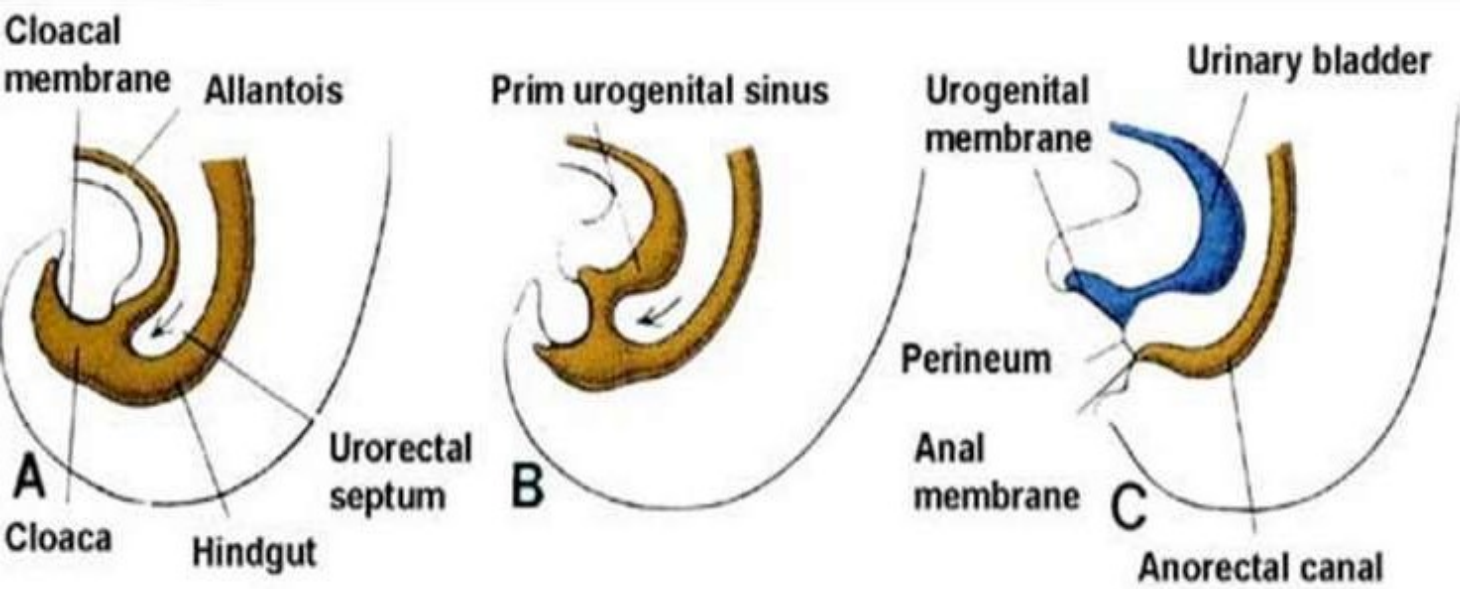
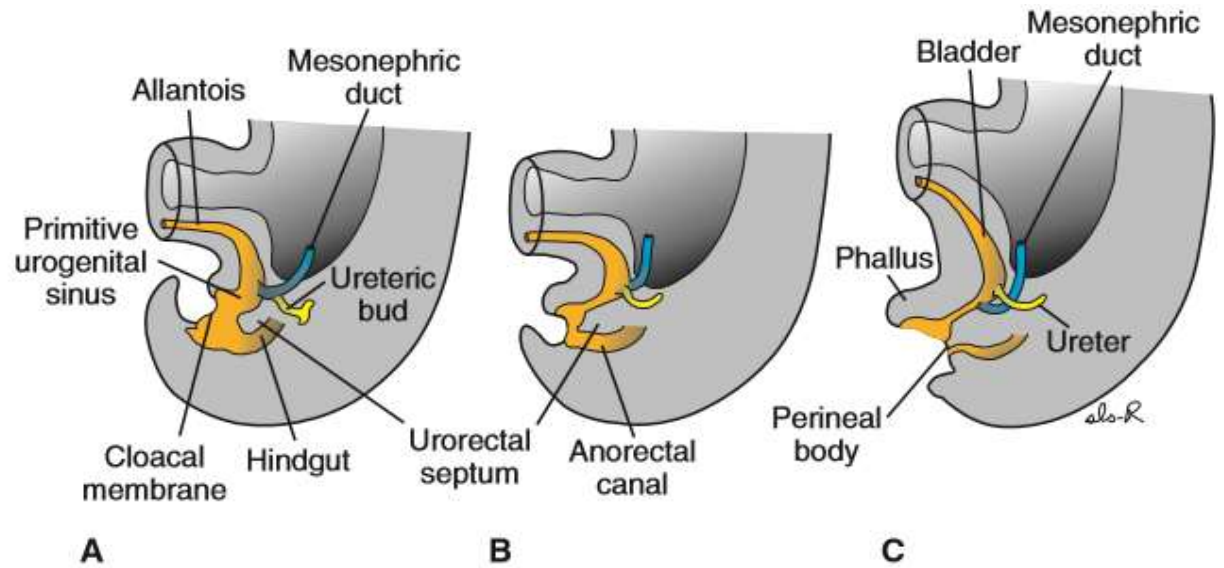
The remnant of urorectal septum is perineal body and recto vesical fascia (Denonvilliers' fascia)

## The cloaca is divided into two parts:

- **Ventral part** called the primitive urogenital sinus, which is continuous with the allantois and still receives the right and left mesonephric ducts.
- **Dorsal part** called anorectal canal, which is continuous with the hindgut and gives rise to the rectum and the upper part of the anal canal.

## the cloacal membrane is also divided into two parts.

- **Ventral part** called the urogenital membrane closes the caudal end of the primitive urogenital sinus.
- **Dorsal part** called the anal membrane closes the caudal end of the anorectal canal.



**A-Urogenital sinus** is subdivided by the openings of mesonephric ducts into **two** parts.

**Cranial part** (the vesico-urethral canal), whose apex is continuous with the allantois.

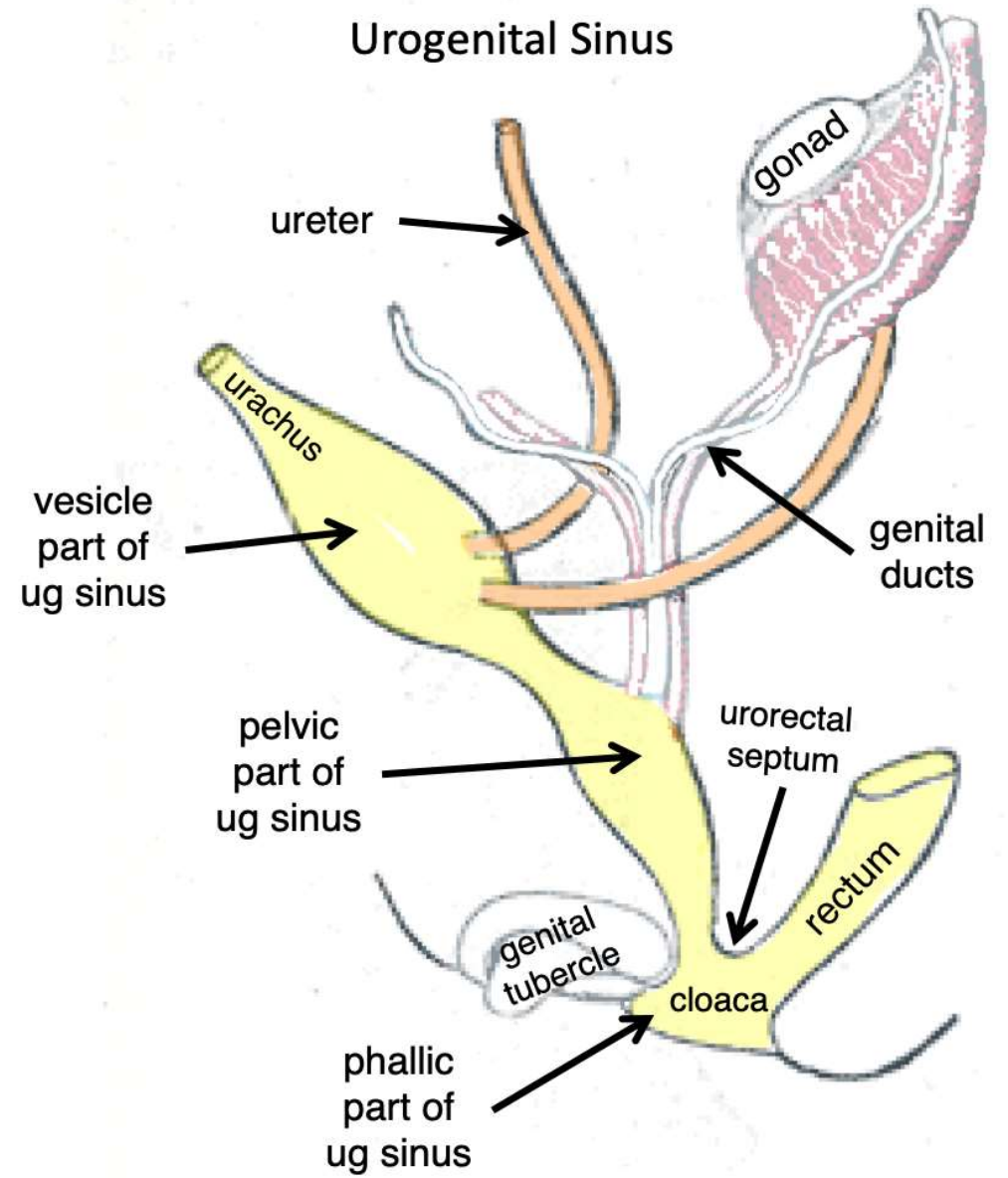
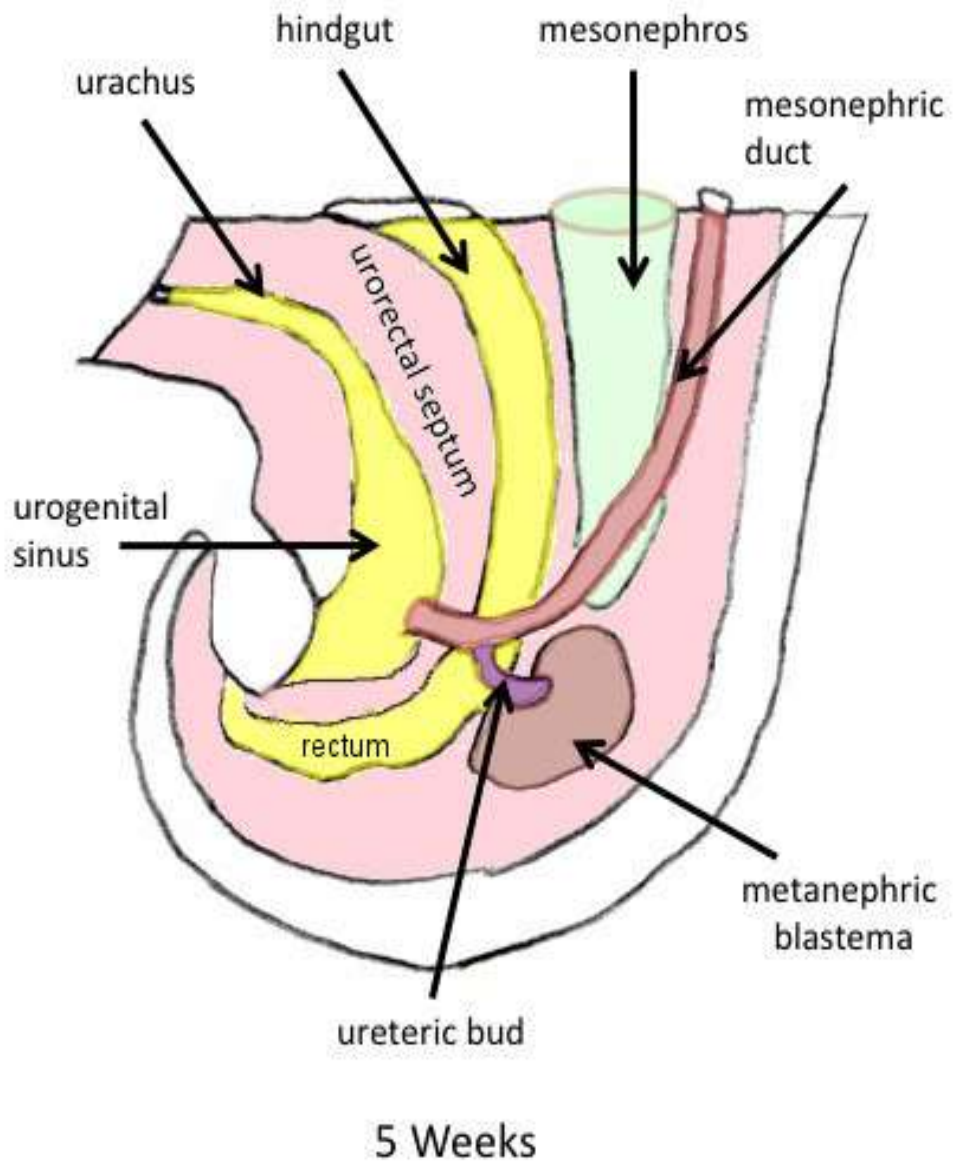
**Caudal part** called the definitive urogenital sinus, which is further subdivided, into : pelvic and phallic parts.

### **B- Allantois**

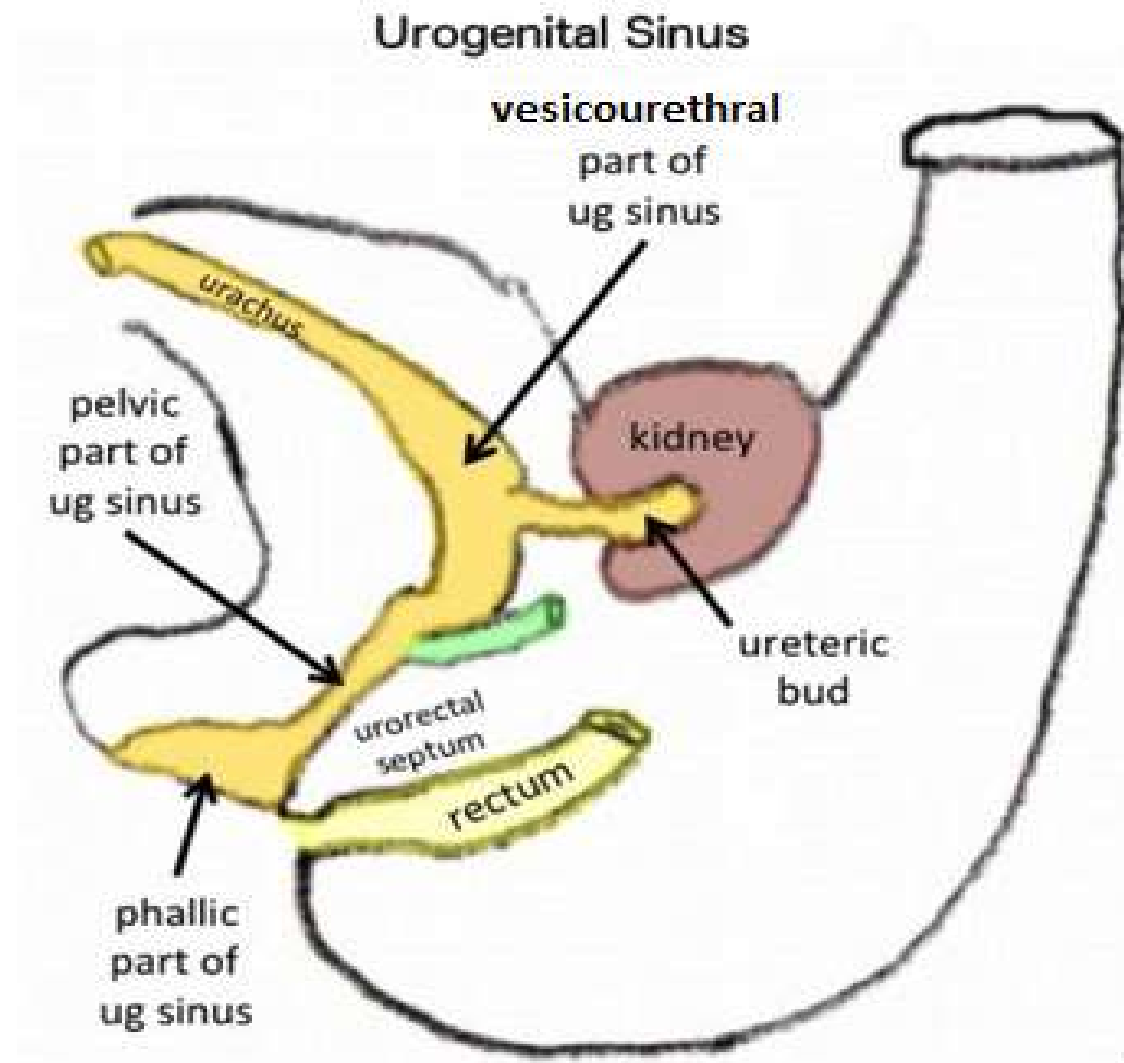
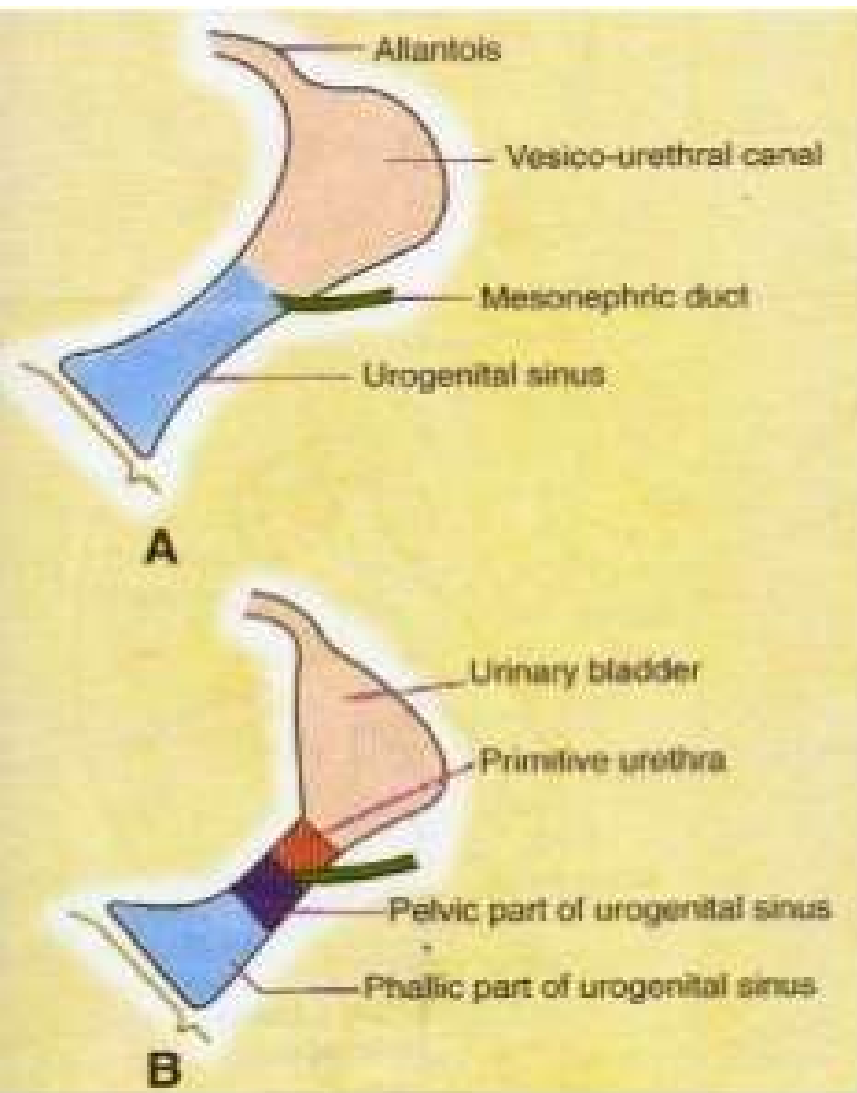
- It constricts to form a fibrous cord called the **urachus** that is continuous with the apex of the urinary bladder.
- After birth, the urachus is transformed into the median umbilical ligament.

### **C- Caudal parts of the mesonephric ducts**

- Below the ureteric buds, the caudal parts of the mesonephric ducts are absorbed into the wall of the urinary bladder forming its trigone.

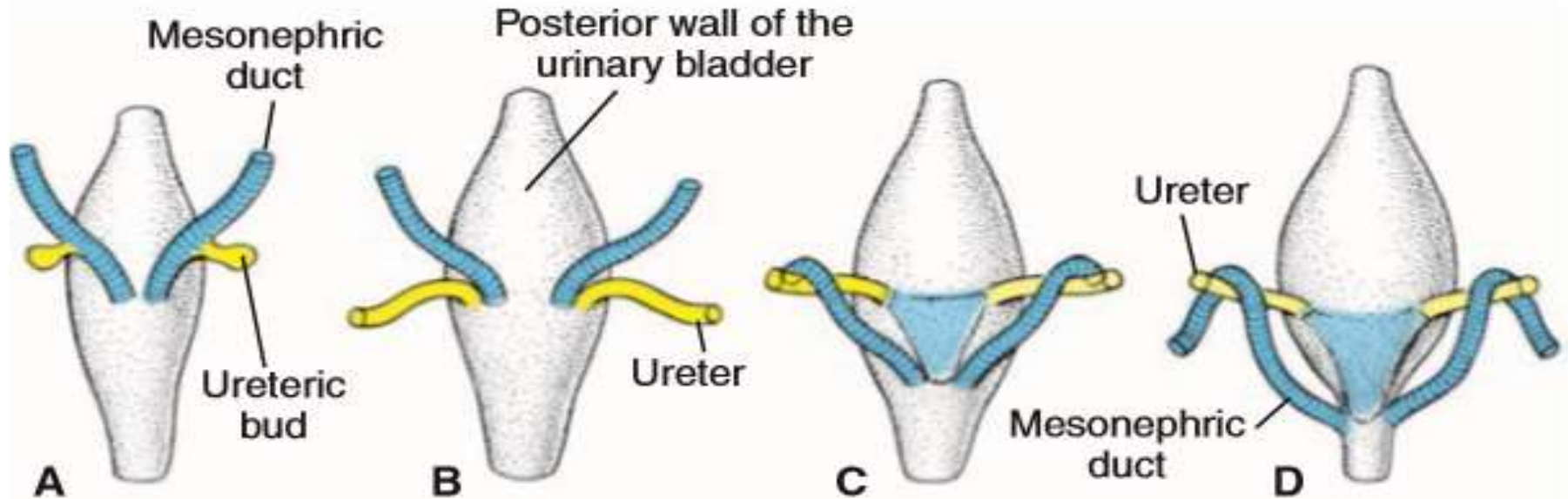






## The urinary bladder develops from :

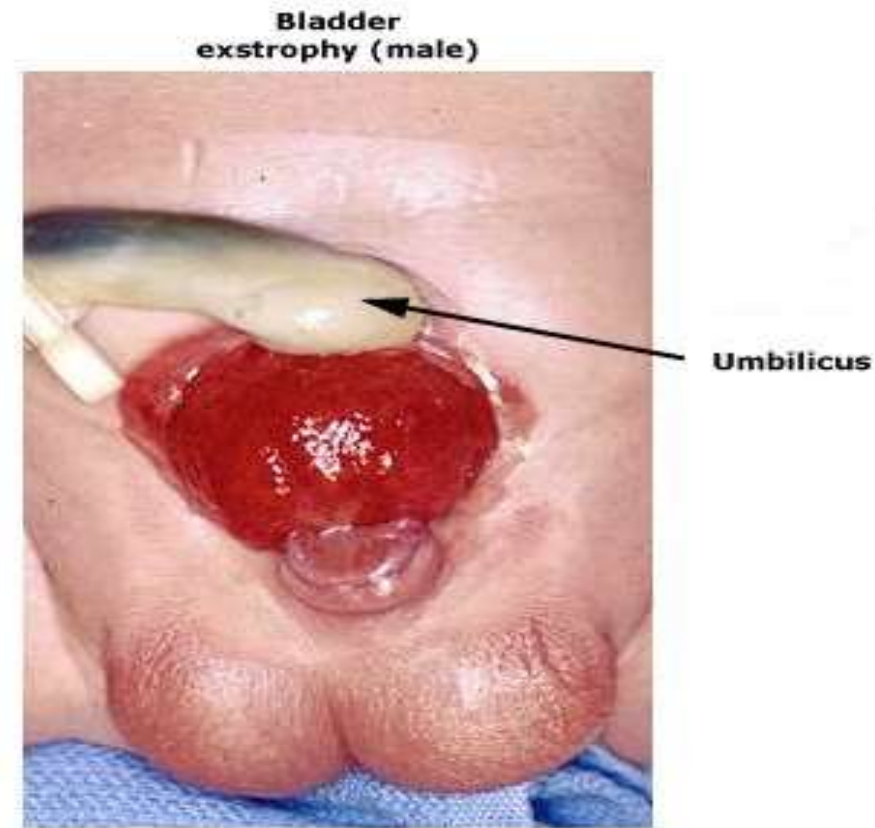
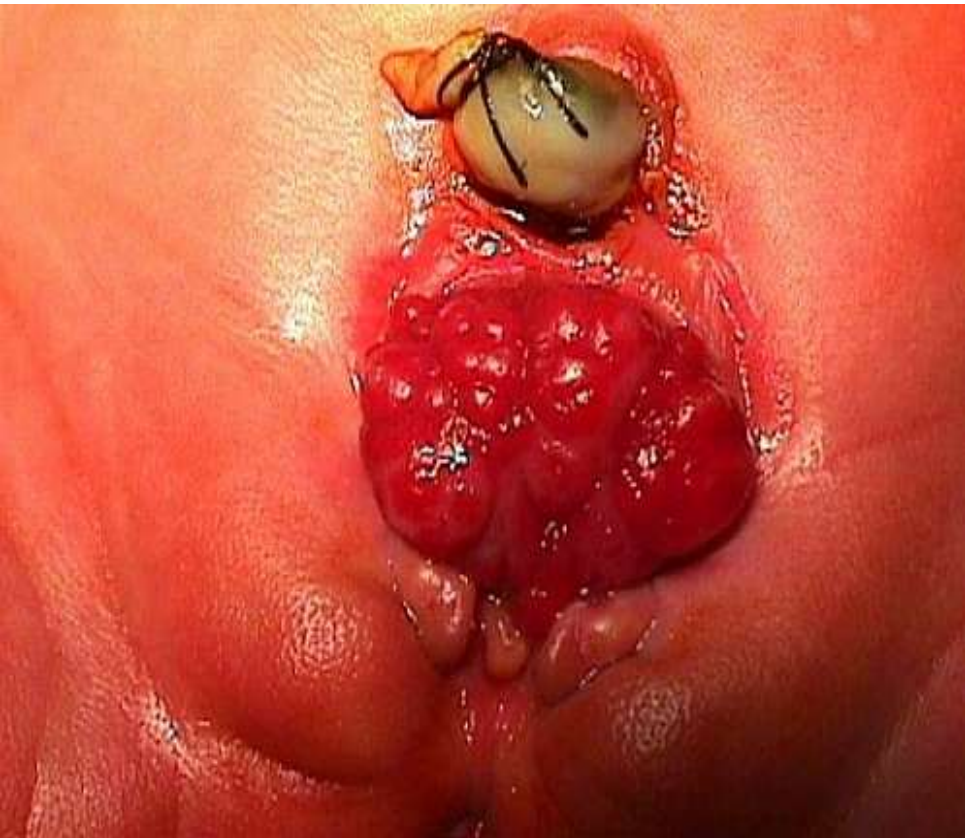
1. Its major part develops from the vesico-urethral canal (endodermal).
2. The trigone (mesodermal) is formed by the lower absorbed parts of the mesonephric ducts.
- 3- The coats of the urinary bladder are derived from the splanchnic mesoderm.



## Congenital anomalies

**Ectopia vesicae** in which the mucosa of the posterior wall of the bladder is exposed to the outside due to defective formation of the infraumbilical of the anterior abdominal wall.

It is usually associated with Epispadias .



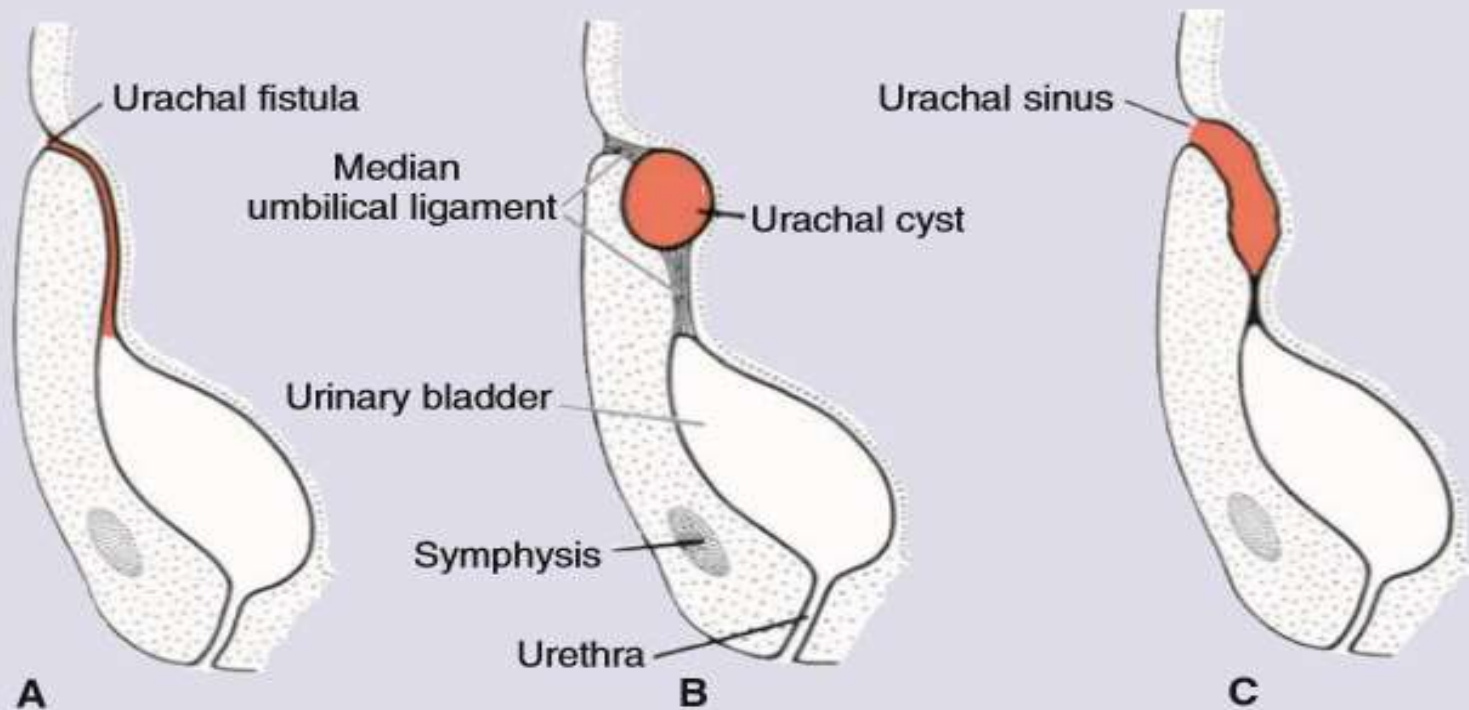
## 2. Anomalies of the urachus

### ➤ **Urachal Fistula (Patent urachus )**

Communication between the bladder and umbilicus through a urachus

### ➤ **Urachal cyst** :a fluid-filled dilatation of the mid urachus

### ➤ **Urachal sinus** :blind focal dilatation of the umbilical end of the urachus



**Figure 16.15** A. Urachal fistula. B. Urachal cyst. C. Urachal sinus. The sinus may or may not be in open communication with the urinary bladder.



# Development of the urethra

Dr Ahmed Salman

## A. Male urethra

### 1. Prostatic urethra.

- It is divided by the seminal colliculus into:

- **Supracollicular part** develops from the **vesico-urethral** part (**endodermal**) of the primitive urogenital sinus except its dorsal wall which develops from the absorbed lower parts of the mesonephric ducts (**mesodermal**).

- **Infracollicular part** develops from the pelvic part of the urogenital sinus.

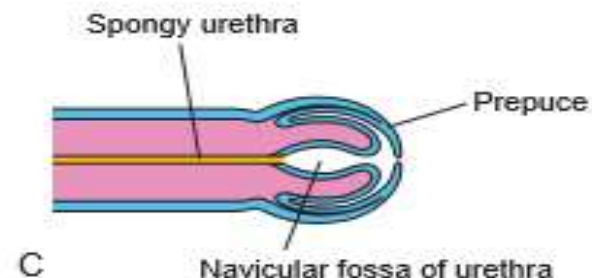
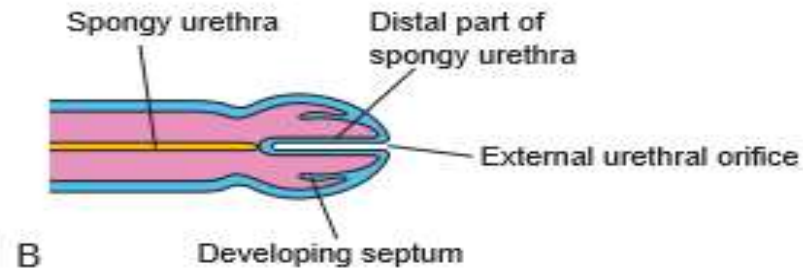
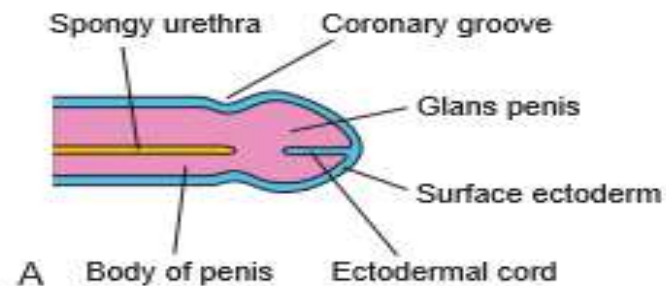
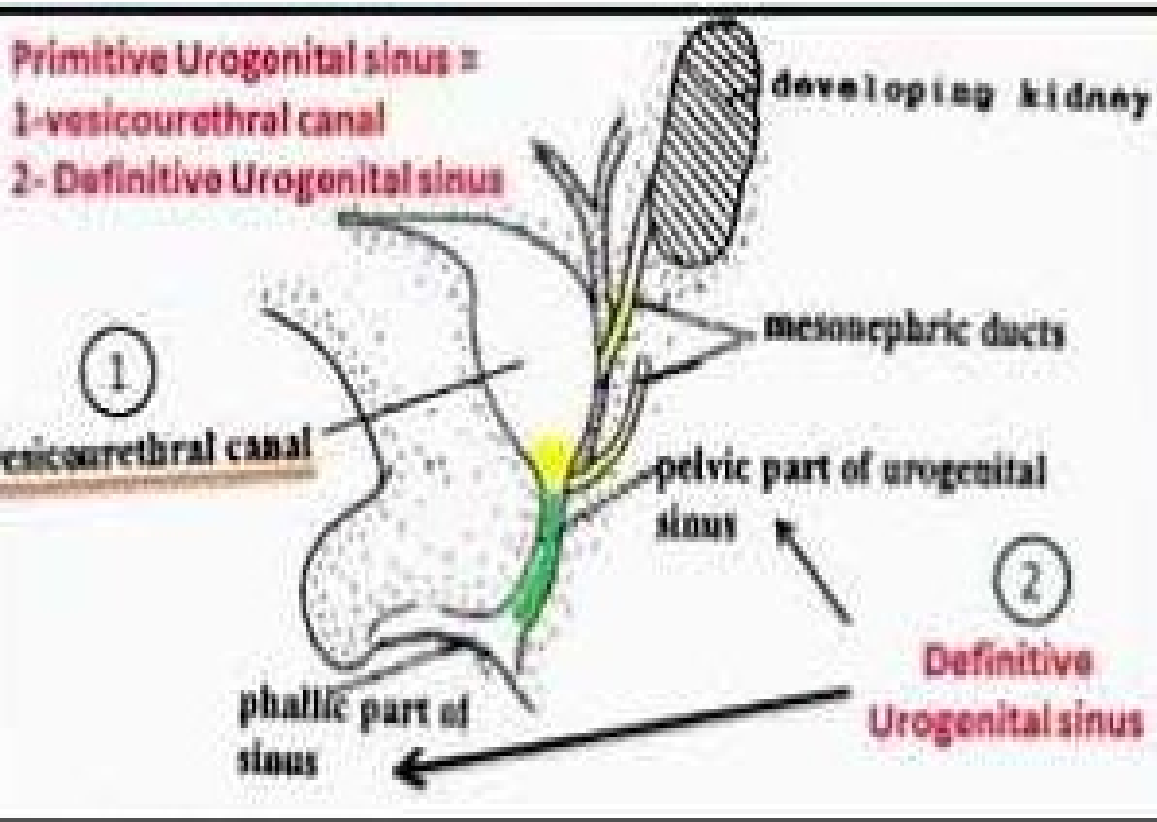
### 2. Membranous urethra:

develops also from the **pelvic** part of the urogenital sinus.



### 3. Penile (spongy) urethra :

- Develops from the phallic part of the primitive urogenital sinus (due to fusion of the two urethral folds) **except** its terminal part within the glans penis, which develops from an **ectodermal** ingrowths.
- The glandular plate becomes canalized to form the navicular fossa.
  - N.B.** The male urethra develops from endoderm **except** two parts.
  - The dorsal wall of the supracollicular part of the prostatic urethra (mesodermal).
  - The terminal part within the glans penis (ectodermal).



## **B. Female urethra**

It develops from the vesico-urethral canal (endodermal) **except** its dorsal wall, which is **mesodermal** in origin, being derived from the absorbed lower parts of the mesonephric ducts.

## Derivatives of the three parts of the urogenital sinus

	Male	Female
1. vesico-urethral	<ul style="list-style-type: none"> <li>- The urinary bladder <b>except</b> its trigone, which is mesodermal in origin.</li> <li>- The supracollicular part of the prostatic urethra <b>except</b> its dorsal wall which is mesodermal in origin</li> </ul>	<ul style="list-style-type: none"> <li>- The urinary bladder <b>except</b> its trigone, which is mesodermal in origin.</li> <li>- The whole urethra <b>except</b> its dorsal wall, which is mesodermal in origin</li> </ul>
2. Pelvic part	<ul style="list-style-type: none"> <li>- The infracollicular part of the prostatic urethra.</li> <li>- Membranous urethra</li> </ul>	<ul style="list-style-type: none"> <li>- The pelvic and the phallic parts form: <ul style="list-style-type: none"> <li>a) Lower 2/5 of the vagina.</li> <li>b) Vestibule of the vagina</li> </ul> </li> </ul>
3. Phallic part	<ul style="list-style-type: none"> <li>- The penile urethra except its terminal part in the glans penis, which is <b>ectodermal</b> in origin.</li> </ul>	



**THANK YOU**