

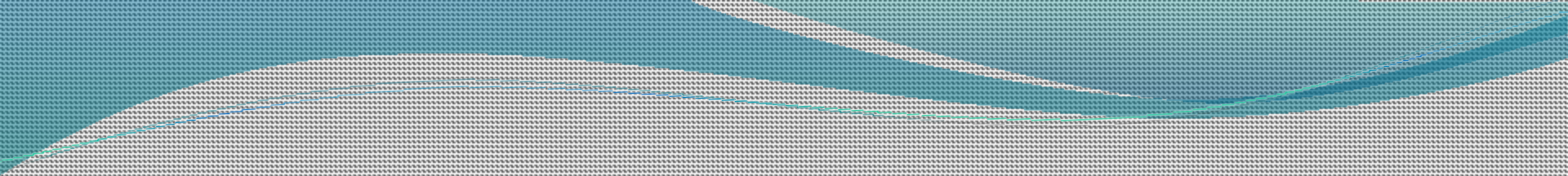
Embryology of Renal System



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Palestinian Board of General Surgery

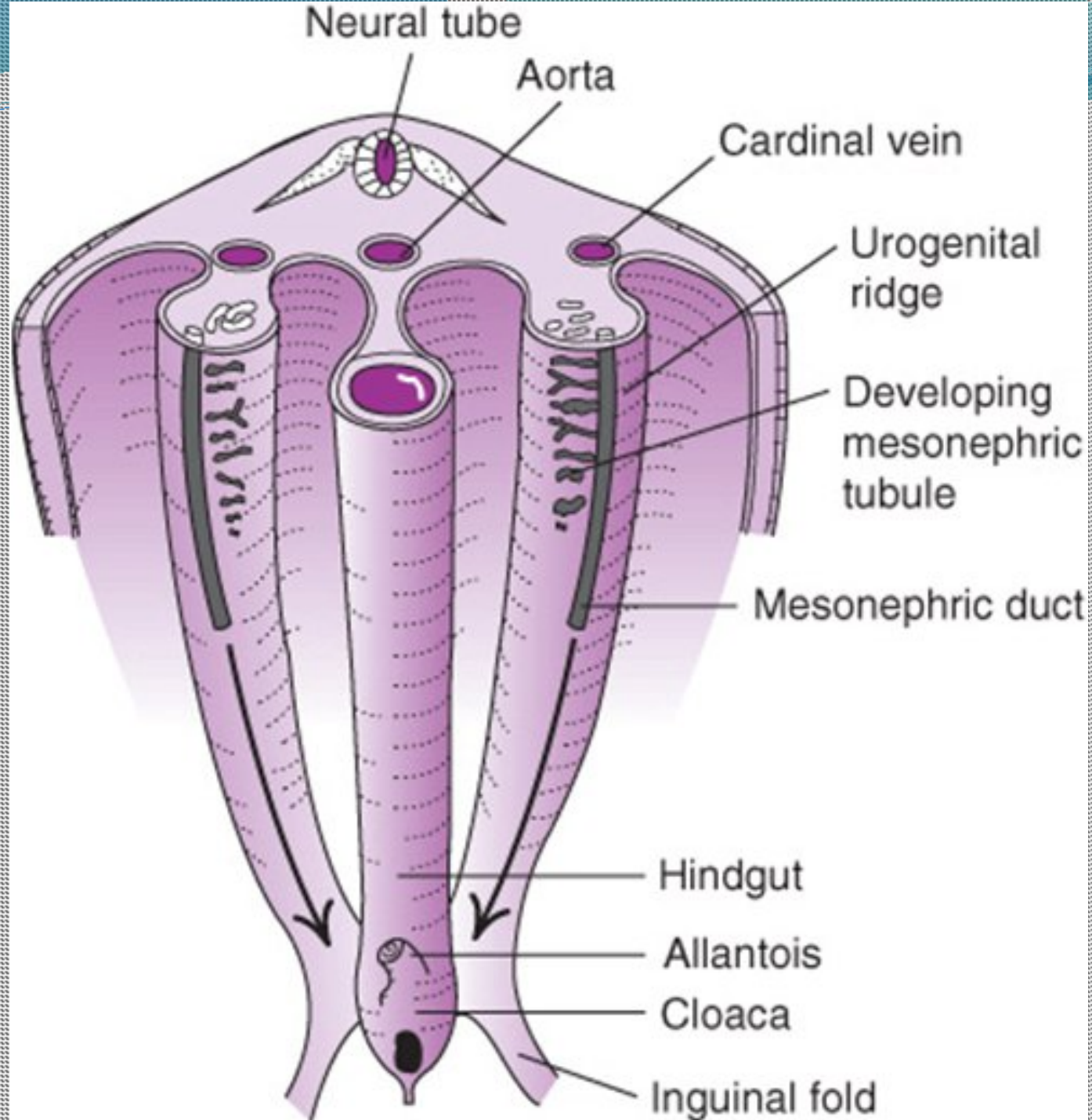
Al Makassed hospital – Jerusalem

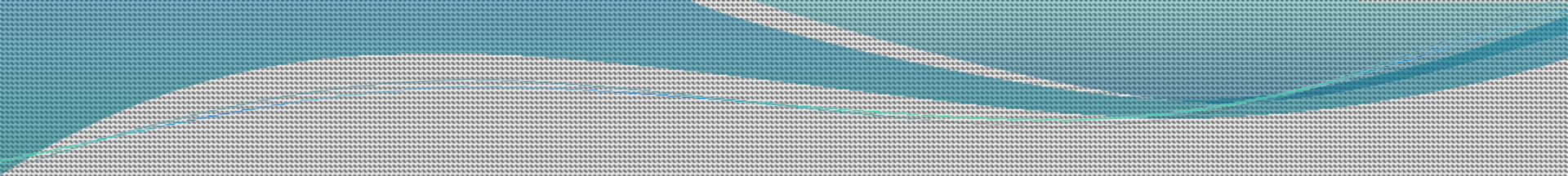


Functionally , the urogenital system can be divided into two different component :

1- The urinary system

2- The genital system





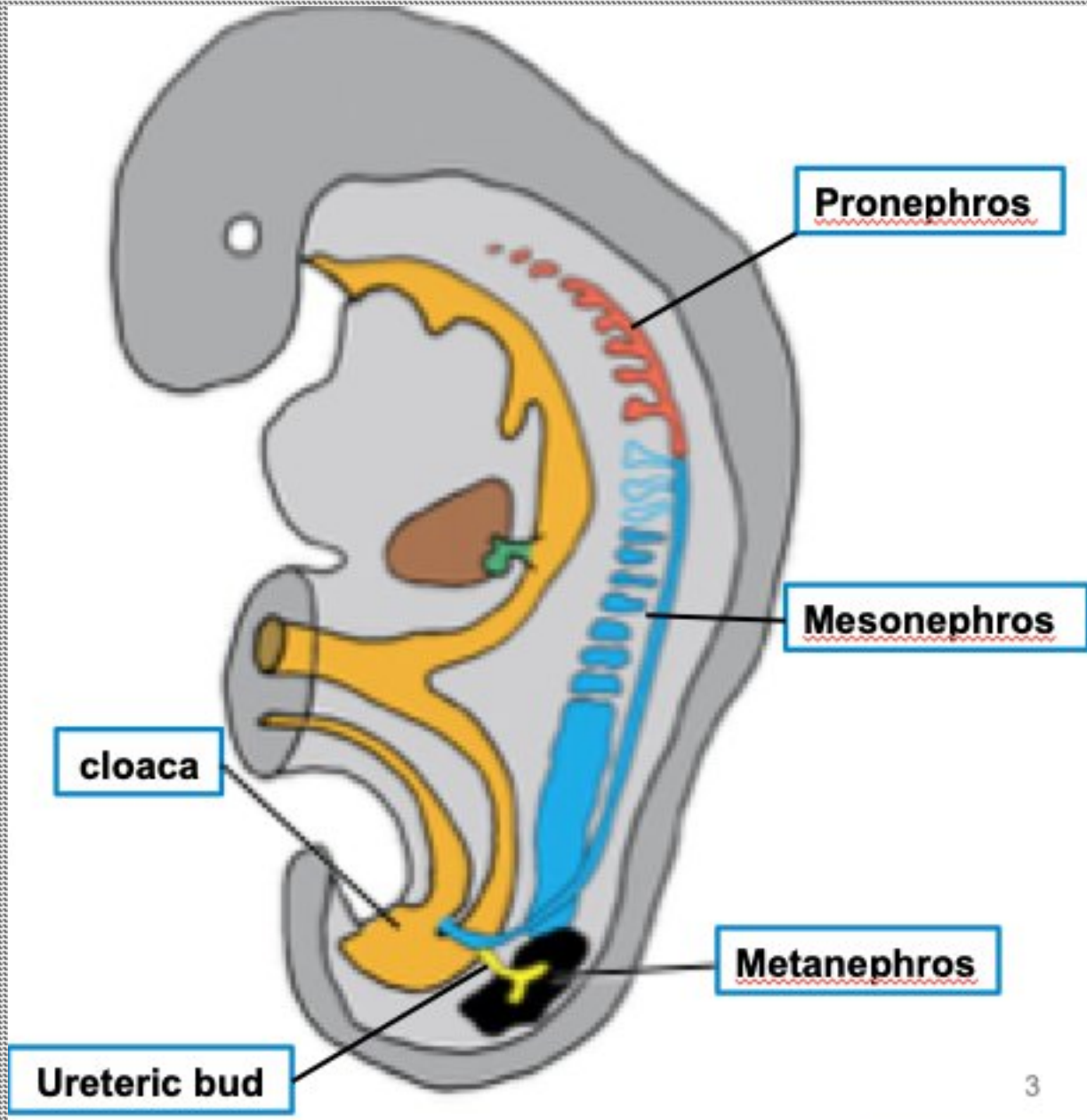
Both systems are interrelated both embryologically and anatomically :

- a. Both develop from the **intermediate mesoderm** along the posterior wall of the abdominal cavity.
- b. In male, **the primitive excretory duct** first functions as urinary duct, but later its transformed into the main genital duct.
- c. The excretory ducts enter a common cavity ; the **cloaca**.

Development of the Kidney

Three different, slightly overlapping kidney systems are formed during intrauterine life in humans :

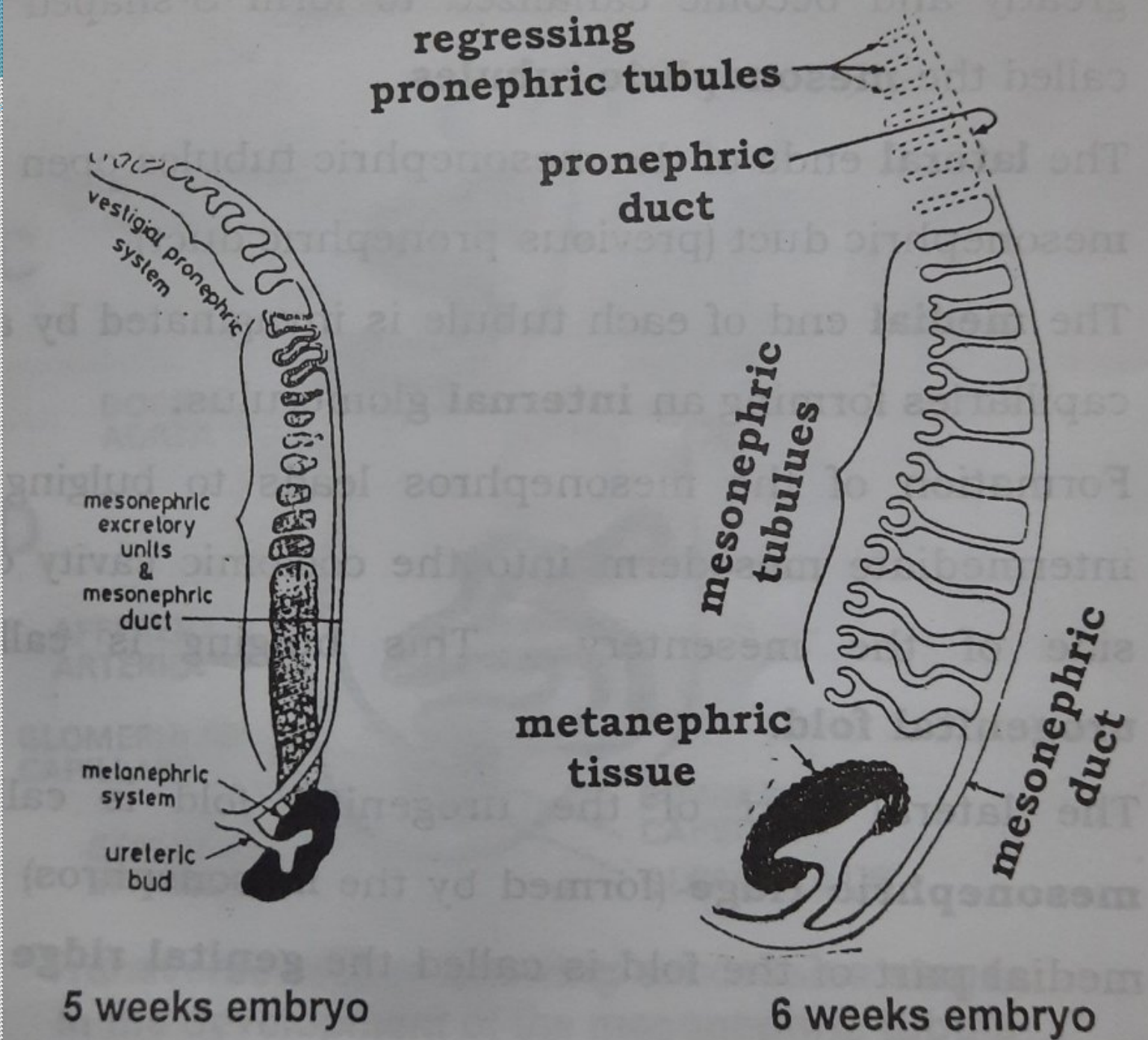
1. **Pronephros** (rudimentary & nonfunctional)
2. **Mesonephros** (short time functional in early fetal period)
3. **Metanephros** (permanent kidney)

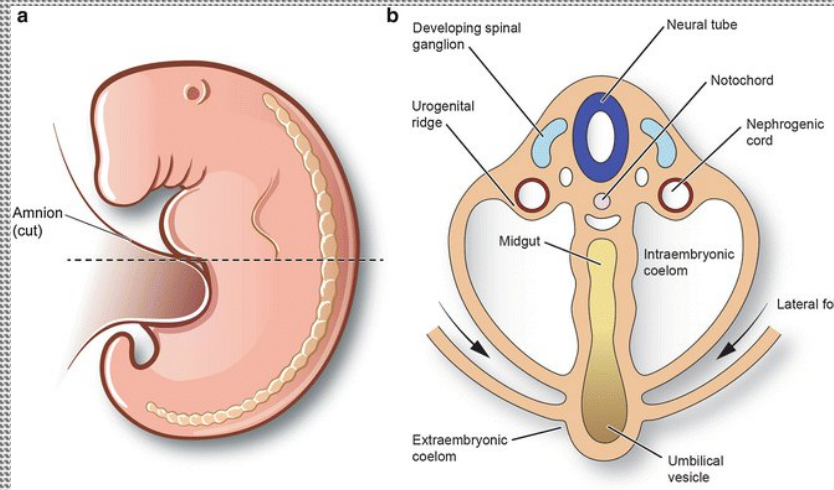
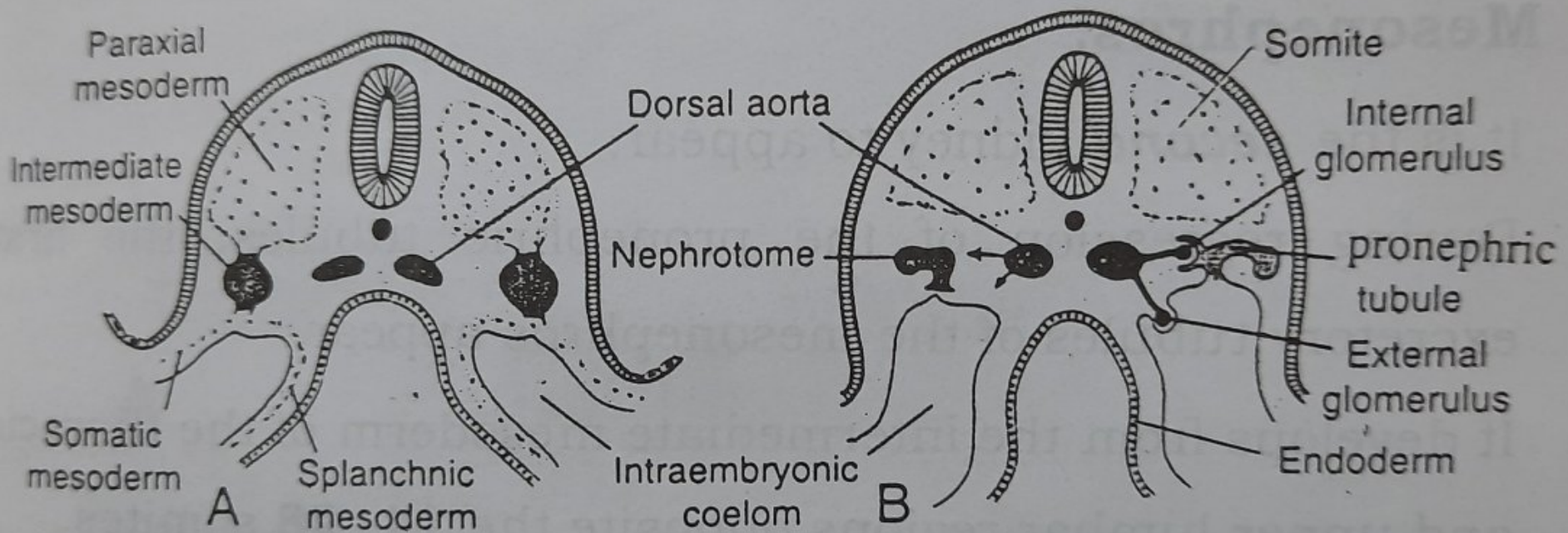


Pronephros

It is the **first** kidney to appear at the 4th week.

It is represented by 7-10 solid cell groups in the **cervical region** known as nephrotomes. As they obtain lumina , they form 7-10 rudimentary pronephric tubules.





Pronephros

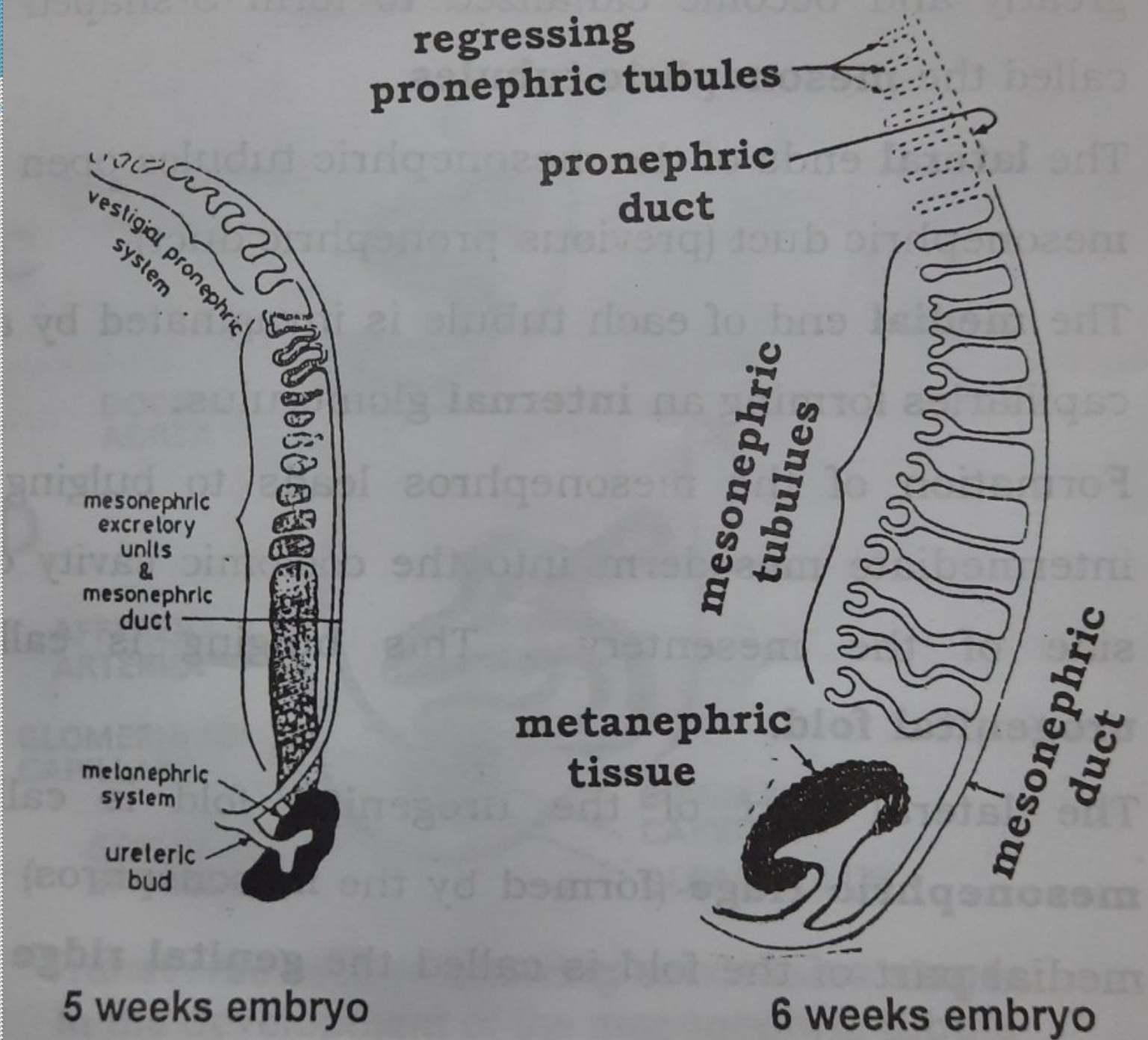
The pronephric tubules degenerate early at the end of the 4th week and the pronephric duct persists to the next stage where it is called the **mesonephric duct** .

Mesonephros

It is the **second** kidney to appear.

During regression of the pronephric tubules, the first excretory tubules of the mesonephros appear. (**5th week**)

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



Mesonephros

The intermediate mesoderm undergo segmentation into about **70** solid clusters , on each side. They elongate greatly and become canalized to form S-shaped tubules called the **mesonephric tubules**.

The **lateral** ends of the mesonephric tubules open into the mesonephric duct .

Mesonephros

The **medial** end of each tubule is invaginated by tuft of capillaries forming an **internal glomerulus**.

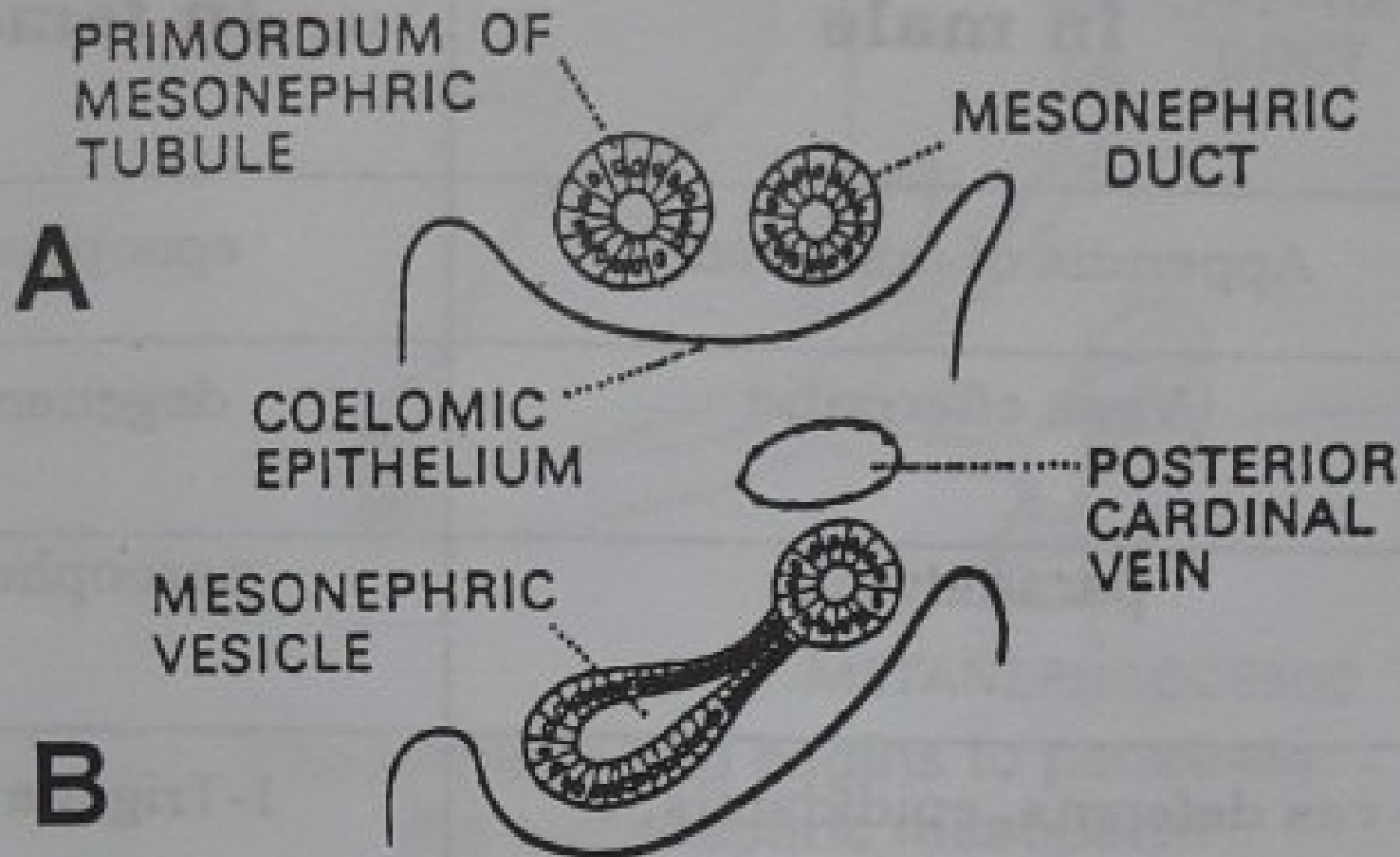
Formation of the mesonephros leads to bulging of the intermediate mesoderm into coelomic cavity on each side of the mesentery. This bulging is called the **urogenital fold**.

Mesonephros

The lateral part of urogenital fold is called **mesonephric ridge** (formed by mesonephros) and the medial part of the fold is called the **genital ridge** (formed by the gonad).

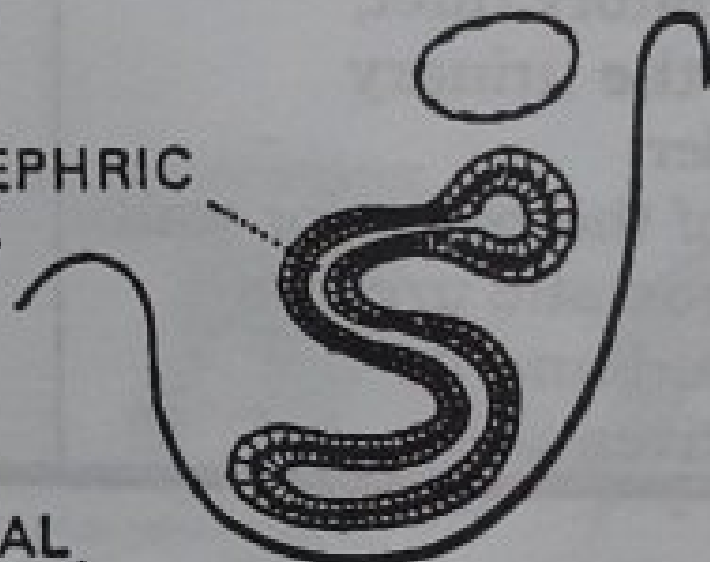
Then, the mesonephric tubules show degenerative changes until they disappear by end of the 2nd month.

Stages of development of mesonephric tubule



C

MESONEPHRIC
TUBULE



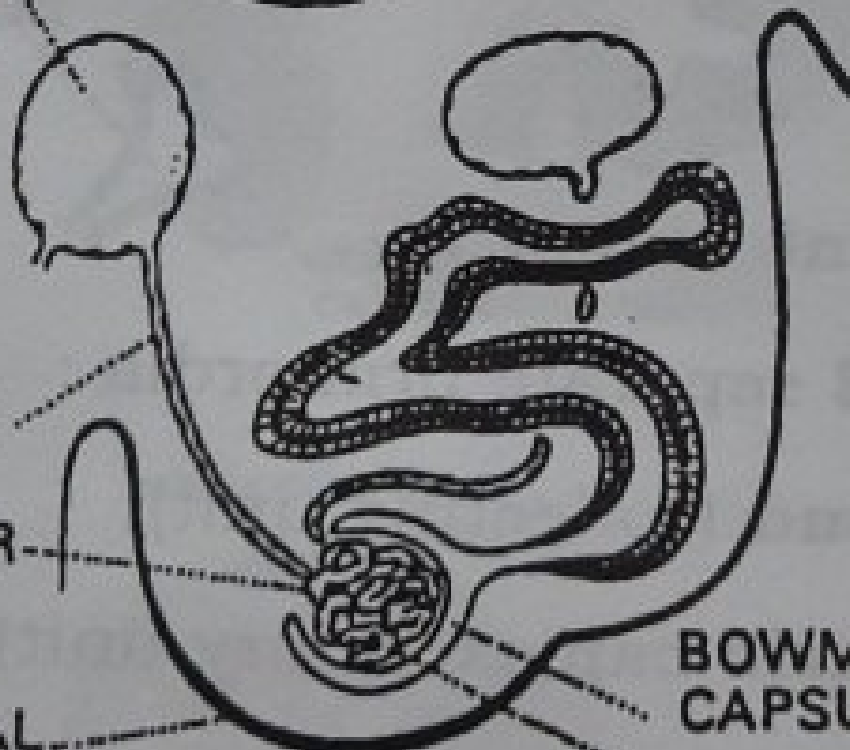
D

DORSAL
AORTA

AFFERENT
ARTERIOLE

GLOMERULAR
CAPILLARY

GERMINAL
EPITHELIUM



BOWMAN'S
CAPSULE

GLOMERULUS

Parts of the mesonephrons persist to form very important derivatives :

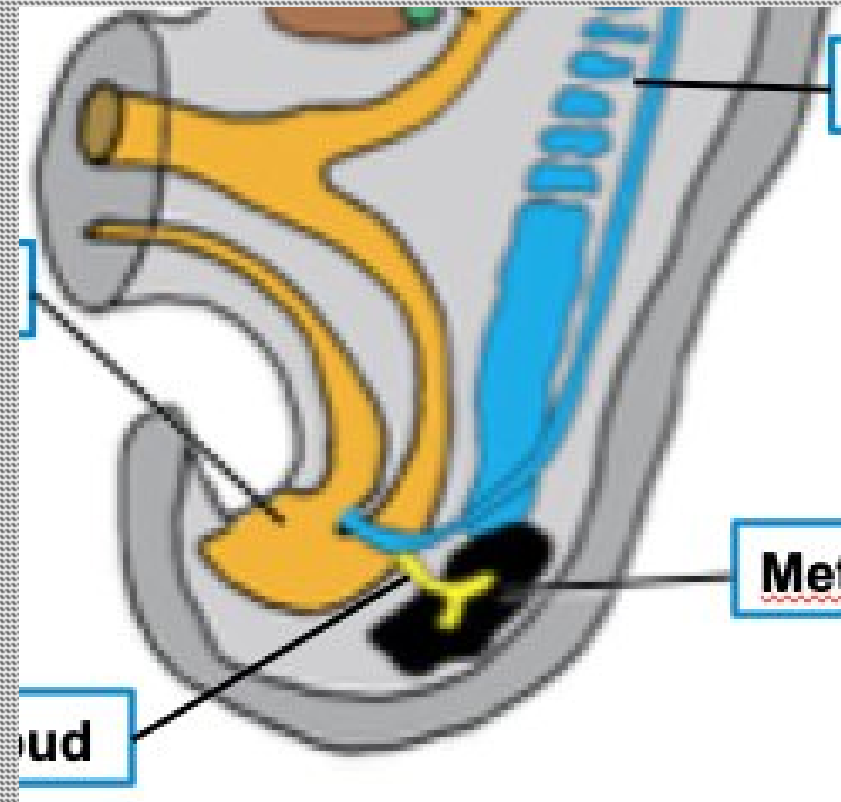
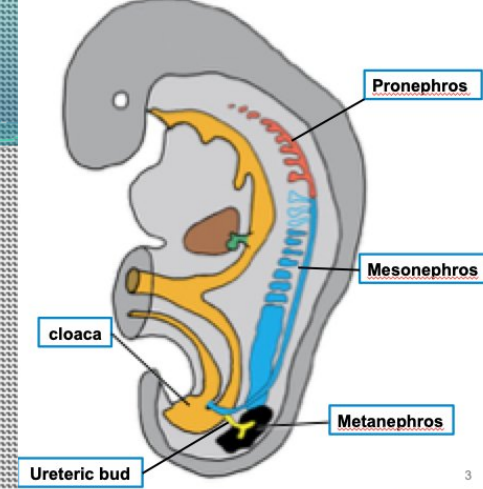
Parts of	In Male	In Female
Upper tubules	Appendix of epididymis	Epoophoron
Middle tubules	Vasa efferentia	Degenerate
Lower tubules	Paradidymis	Paroophoron
Mesonephric ducts	1. Vas deferens , epididymis , seminal vesicle , ejaculatory duct. 2. Trigon of the urinary bladder , upper part of posterior wall of prostatic urethra 3. Ureteric bud and its derivative	4. Trigon of the urinary bladder 5. Ureteric bud and its derivatives

Metanephros

It is the **permanent** kidney.

It develops from 2 separate primordia :

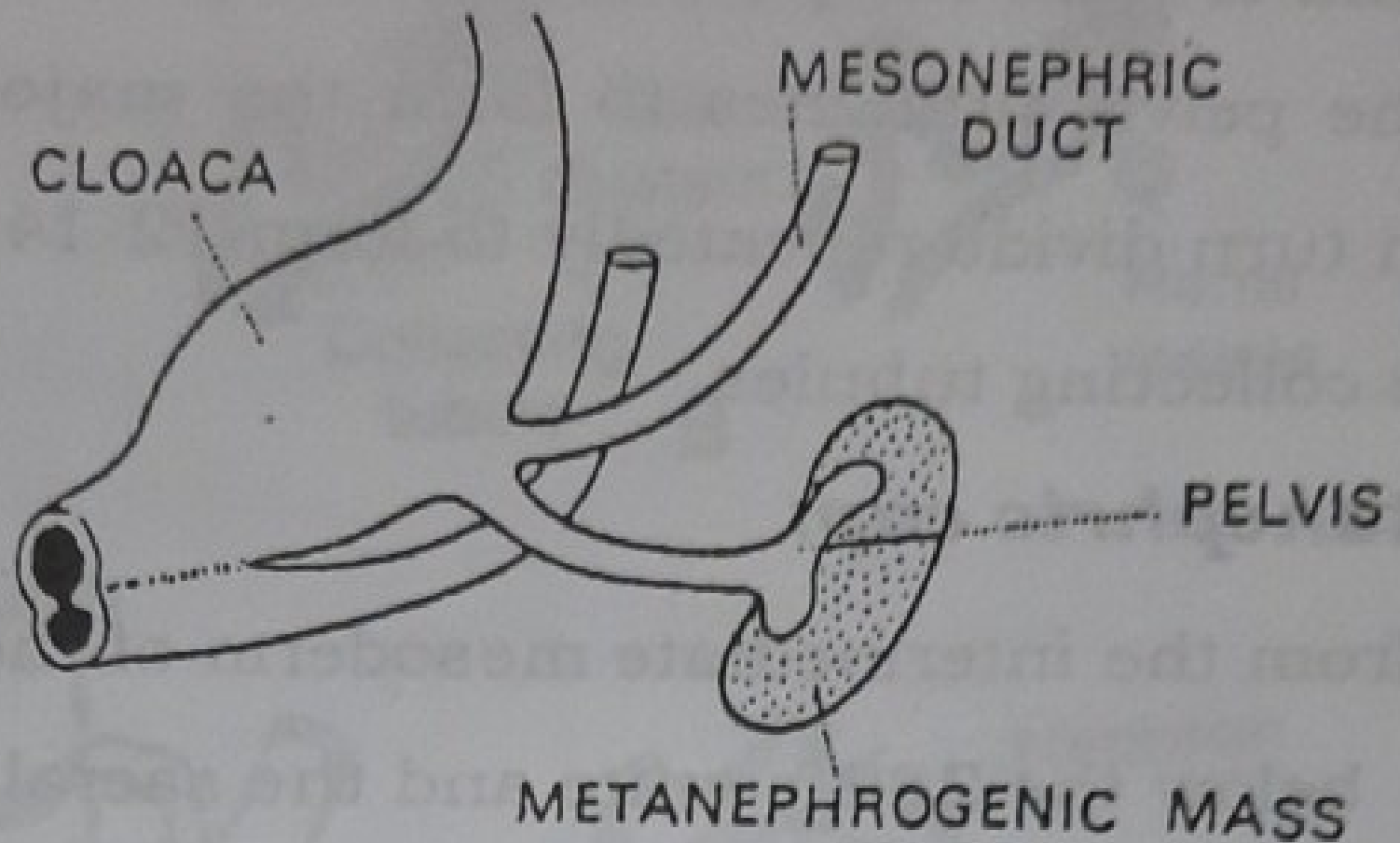
- 1) **The ureteric bud**
(collecting unit)
- 2) **The metanephric cap**
(excretory unit)



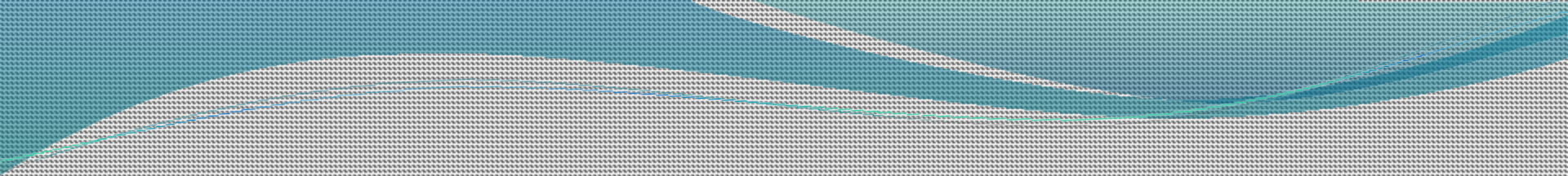
The ureteric bud :

It arises from the caudal part of the mesonephric duct close to its entrance into the cloaca.

The bud grows dorsocranially invading the intermediate mesoderm , which condenses around it to form the **metanephric cap**.



**The ureteric bud begins to penetrate
the metanephric mesoderm**



The ureteric bud forms the **ureter**, which dilates at this upper end to form the **pelvis** of the ureter.

Later the pelvis branches to form the major calyces, and these in turn divide repeatedly to form 12 – 14 minor calyces and the collecting tubules.

metanephrogenic cap
tissue

metanephric
bud

renal
pelvis

major
calyx

minor
calyx

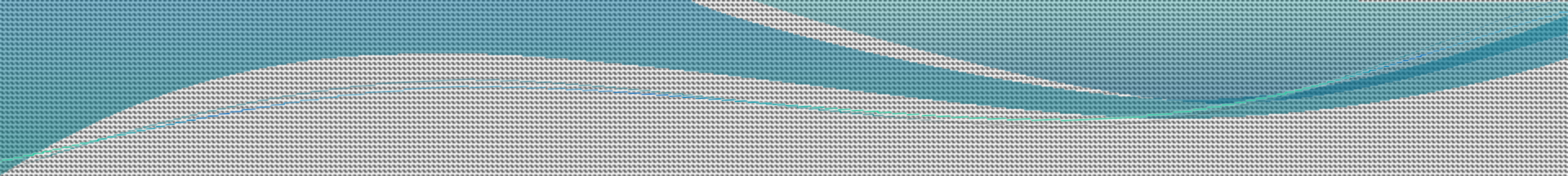
collecting
tubules



The metanephric cap:

Arises from the intermediate mesoderm of the lower lumbar region and the sacral regions .

The mesoderm is segmented into cell clusters in relations to the termination of the collecting tubules .

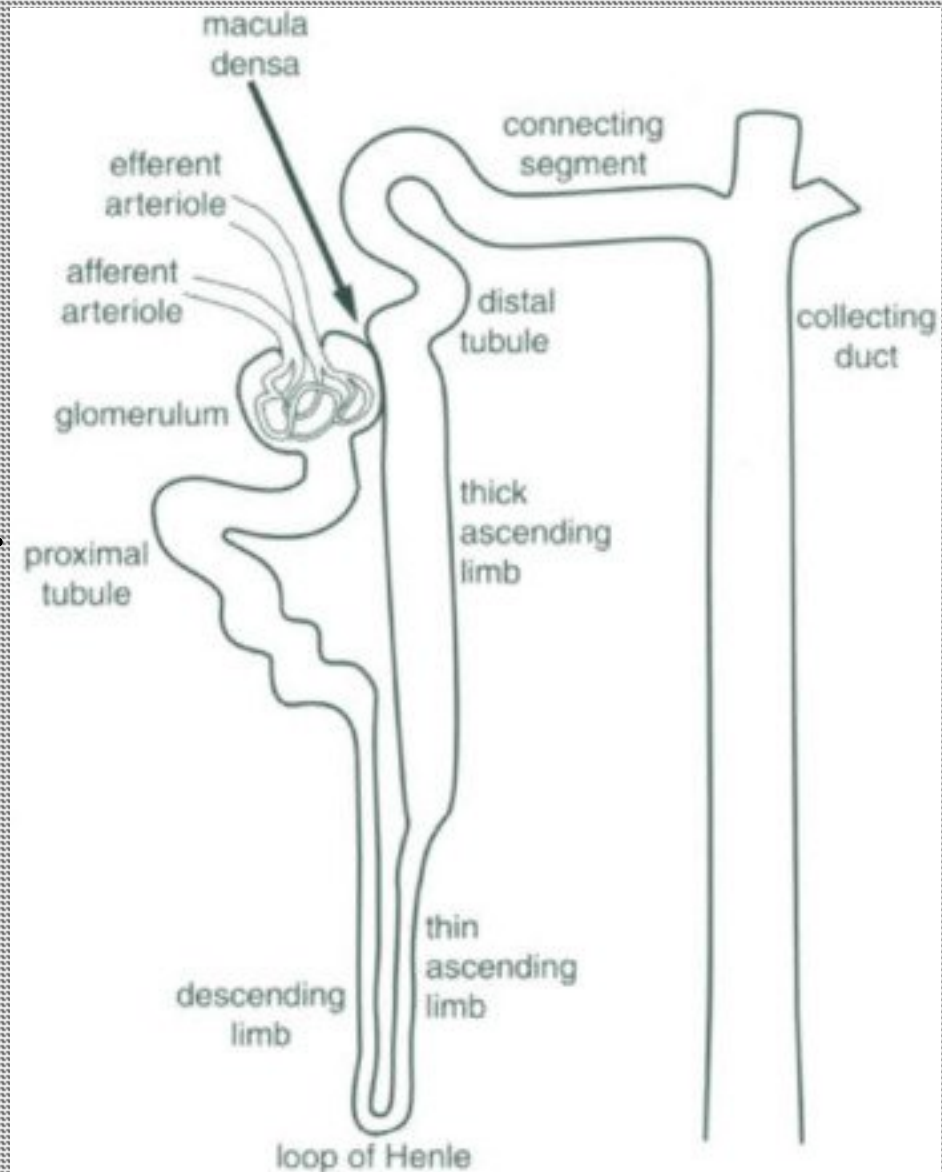


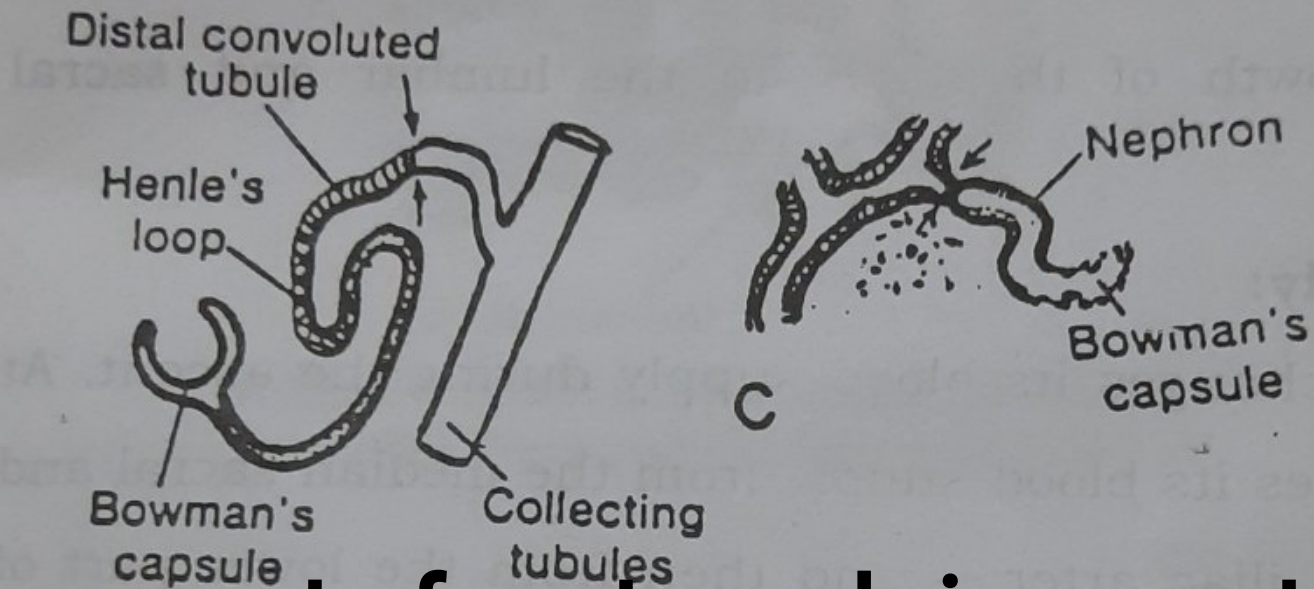
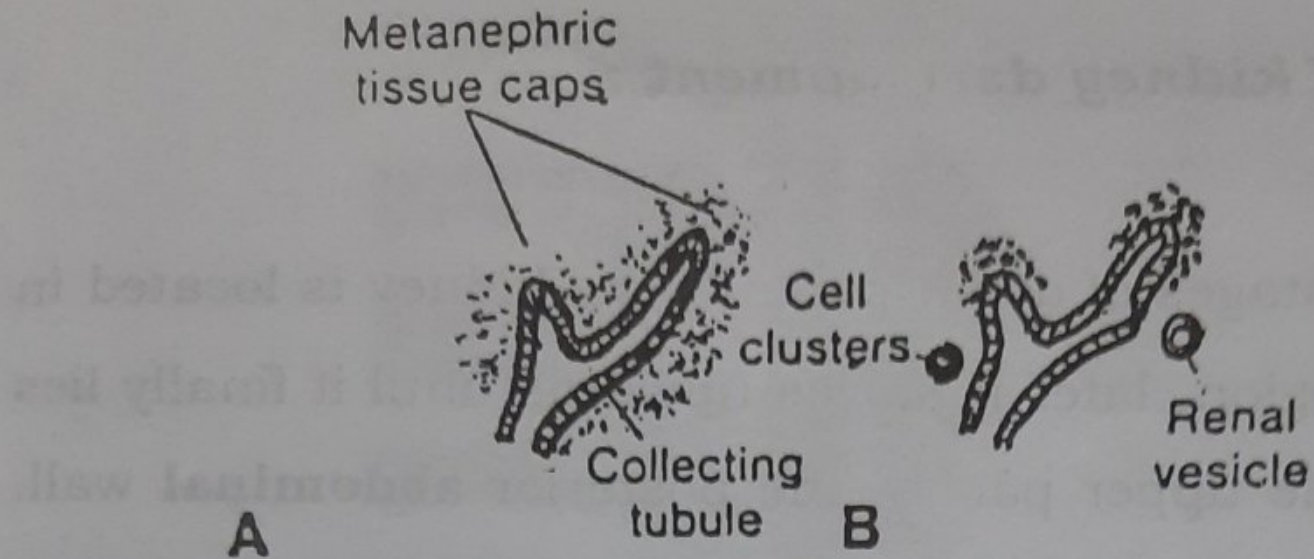
These cell clusters change into **renal vesicles** which elongate to form the different parts of nephron which are :

- >> **Bawman's capsule**
- >> **Proximal convoluted tubule**
- >> **Loop of Henle**
- >> **Distal convoluted tubule**

The proximal glomerular capsule becomes invaginated by a tuft of capillaries that form the glomerulus.

The distal convoluted tubule joins the nearest collecting tubule to form a complete **uriniferous tubule**.





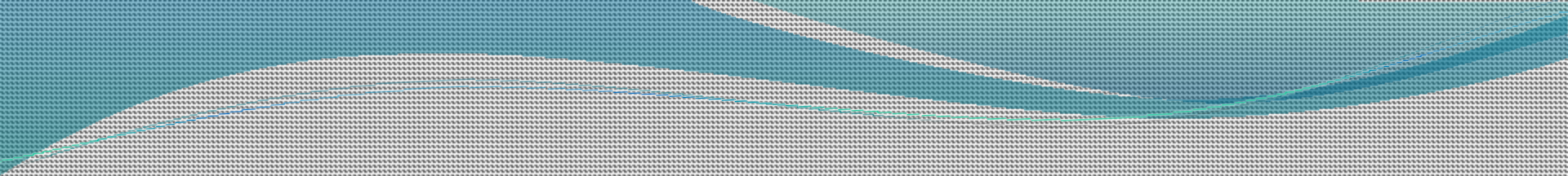
Development of metanephric excretory unit

More signs of kidney development

* Location:

In the early stages of development, the kidney is located in **pelvic** region , later it moves upwards until it finally lies in front of the upper part of the posterior **abdominal** wall.

WHY ?????



Because of a diminution of the body curvature and the growth of the body in the lumbar and sacral regions.

More signs of kidney development

*** Blood supply :**

The kidney changes its blood supply during the ascent.

At first it receives its blood supply from the median sacral and the common iliac arteries and then from the lower part of the abdominal aorta.

More signs of kidney development

*** Shape :** The fetal kidney is lobulated with an irregular surface . This **lobulation** usually disappears before birth as a result of further growth of the nephrons.

*** Position :** In the early stages the convex border of the kidney looks posteriorly and its hilum looks ventrally. Later it rotates about 90 degrees medially that the hilum becomes directed medially .

Congenital anomalies of kidney

(1) Renal Agenesis : (Bilateral and unilateral)

Occurs when the ureteric bud fails to develop

(2) Anomalies of position :

Pelvic kidney : occur when one or both kidneys fail to ascend and remain in the pelvis or lower lumbar area .

Abnormal rotation of the kidney

Congenital anomalies of kidney

(3) Anomalies of shape

Horseshoe kidney :

occurs when the inferior poles of the kidneys fuse together

Polycystic kidney :

the kidney shows many small cysts full with urine due to failure of nephrons to join the collecting tubules .

Congenital anomalies of kidney

(4) Anomalies of urinary tract :

Duplication of the urinary tract :

occurs when the ureteric bud prematurely divides before penetrating the metanephric cap. It results in either double kidney or double ureter and renal pelvis.

Atresia of the ureter :

may occur at the ureteric orifice of the bladder.

Congenital anomalies of kidney

Ectopic ureteric orifice :

In males , the	In females , the
- The lower part of the trigone . - The prostatic urethra - The ejaculatory duct - The seminal vesicles	- The vagina - The urethra - The vestibule

Congenital anomalies of kidney

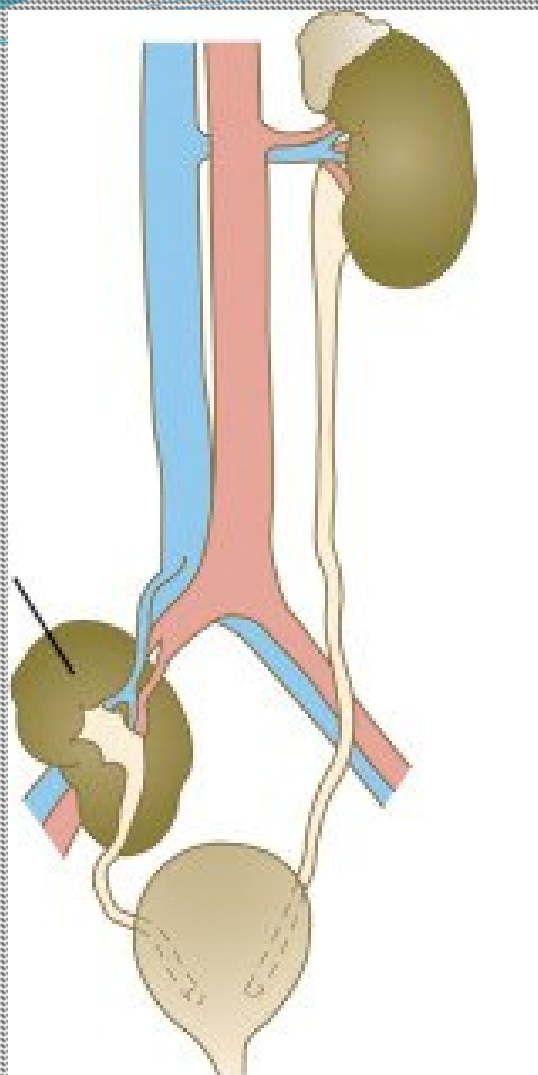
(5) Anomalies of the blood supply :

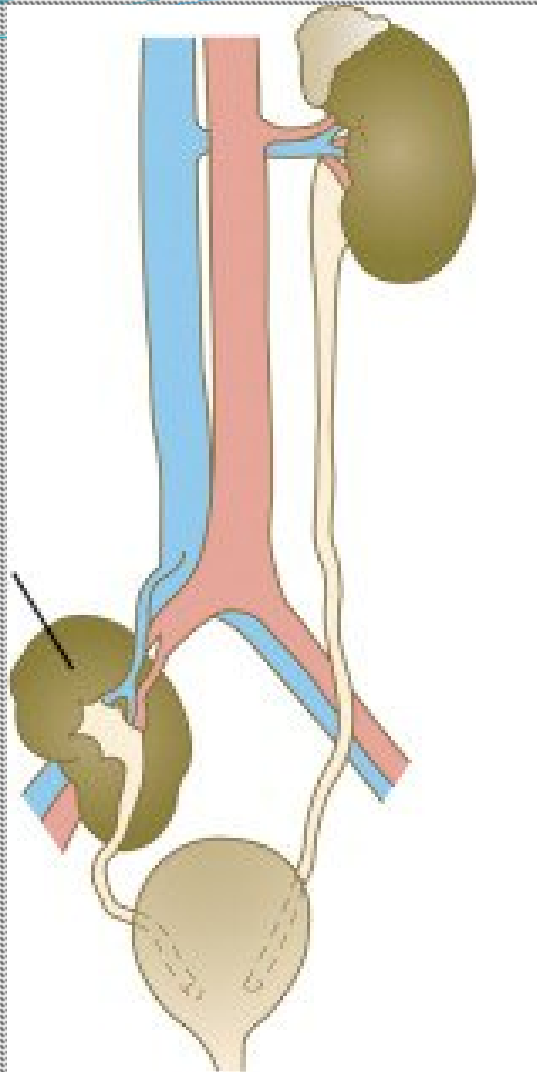
Multiple renal arteries

Accessory renal artery :

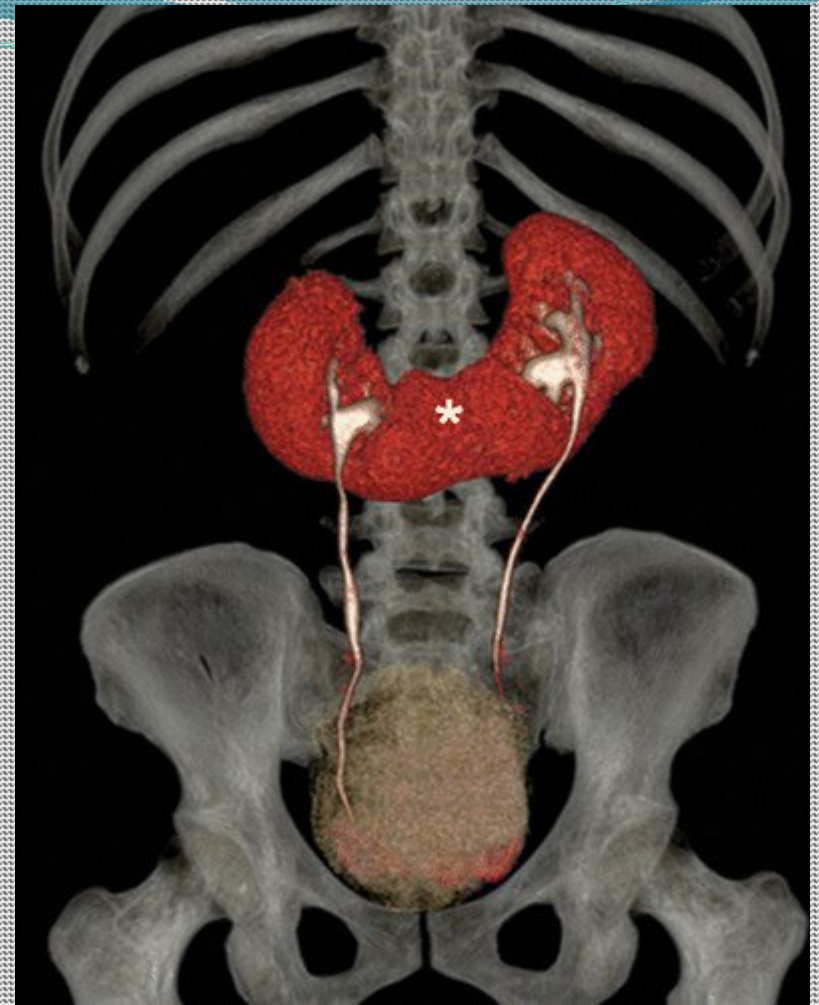
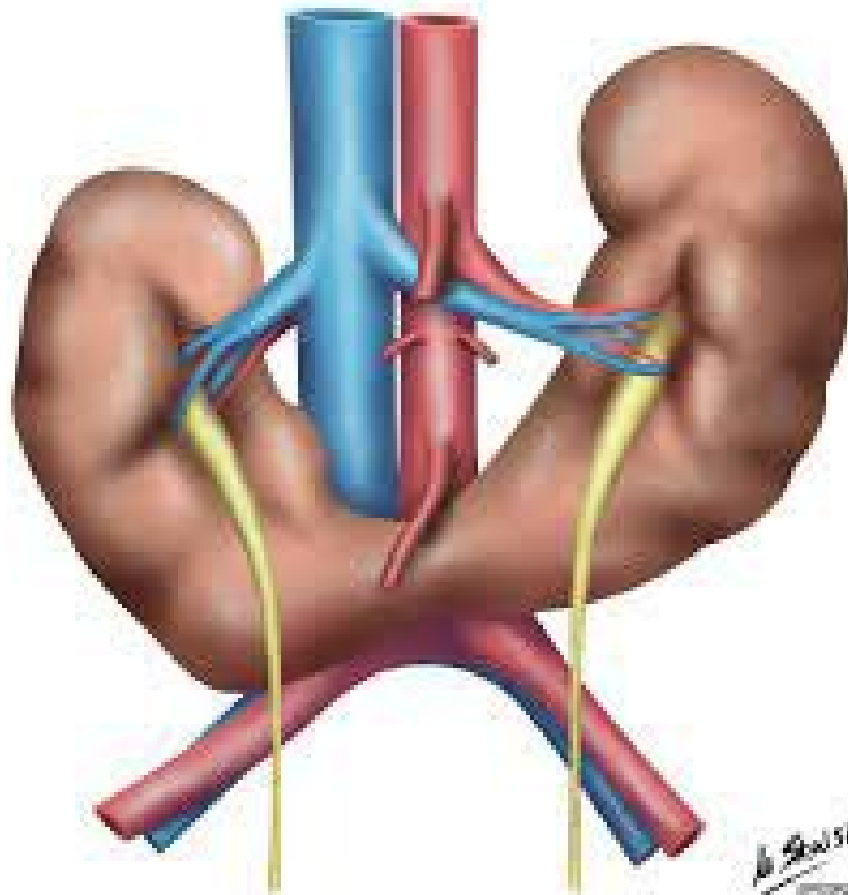
an additional artery may pass into the upper or lower pole of the kidney.

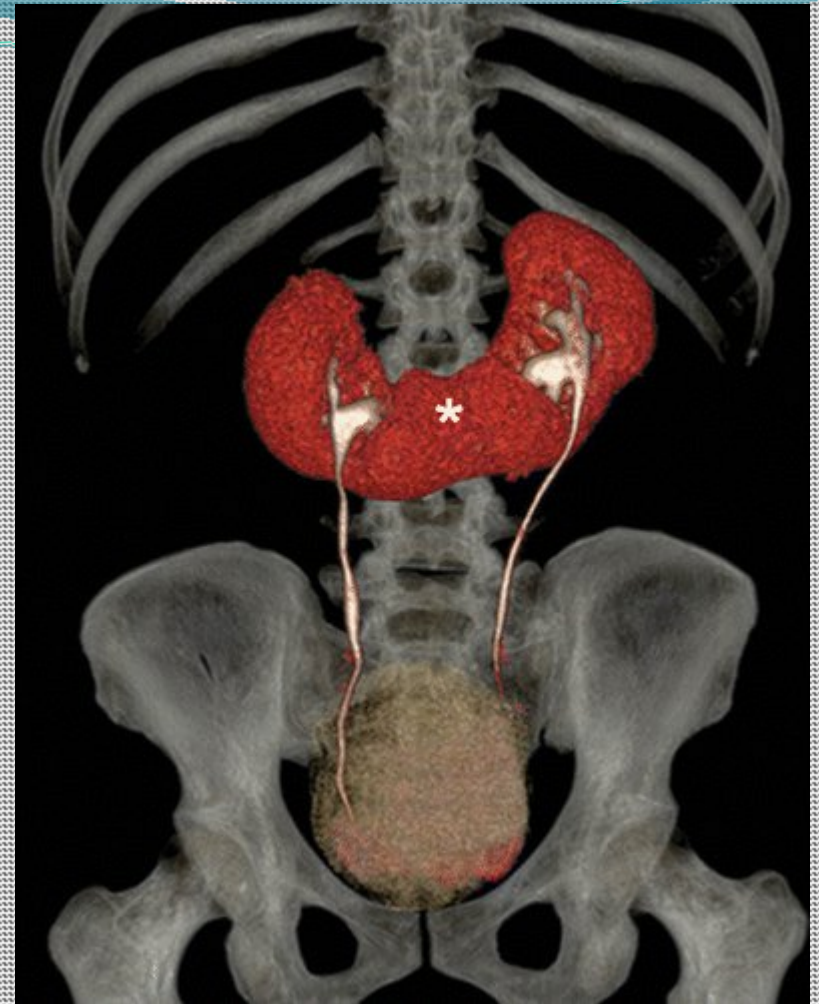
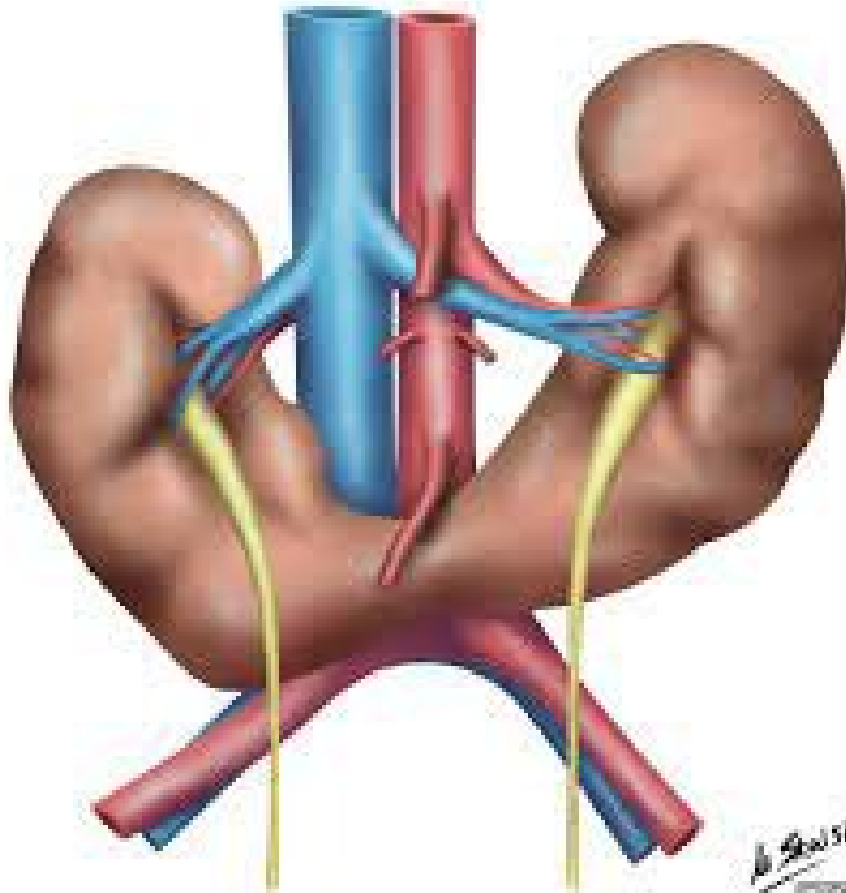
Polar renal artery in the lower pole may obstruct the ureter and dilate the pelvis.





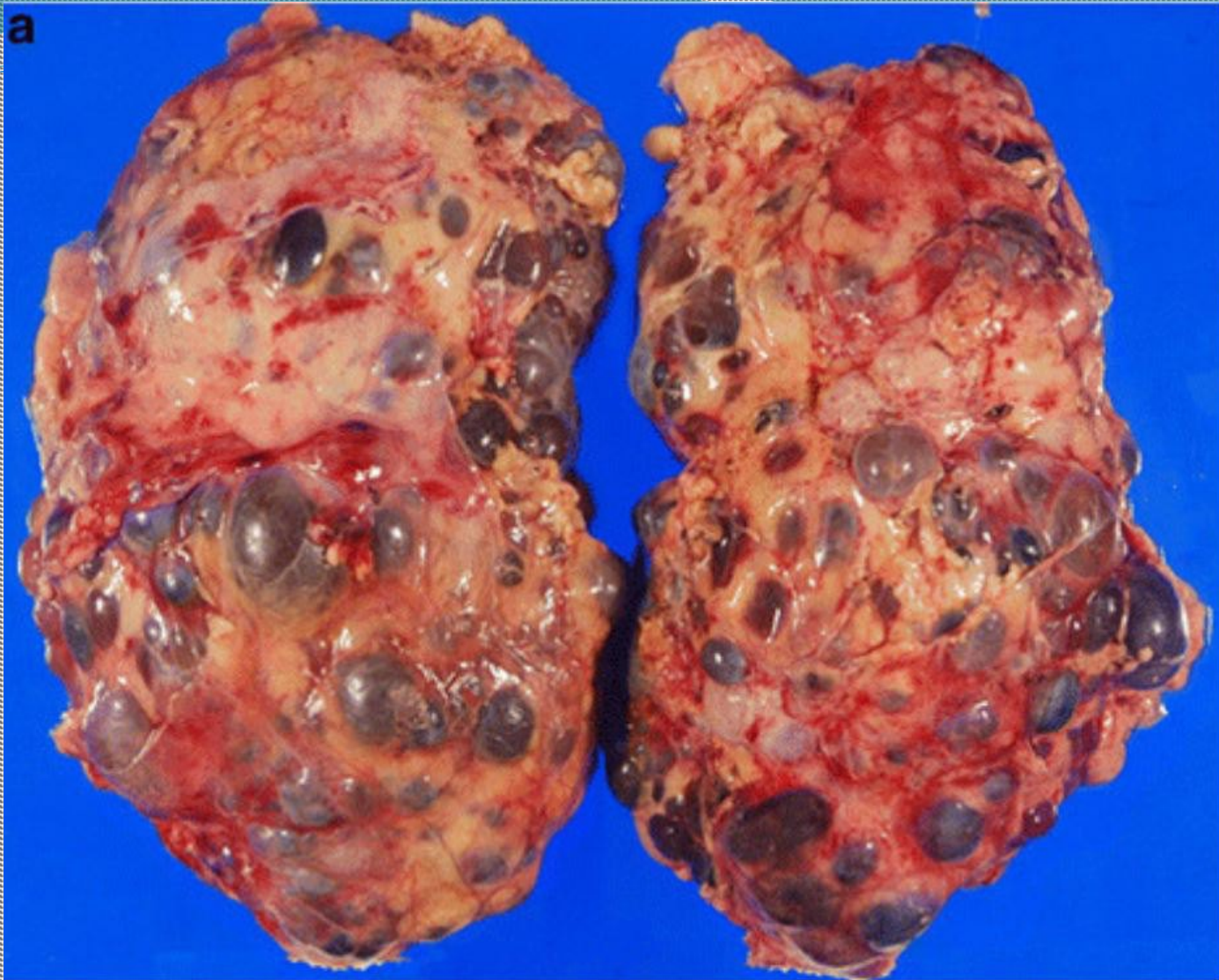
Pelvic kidney

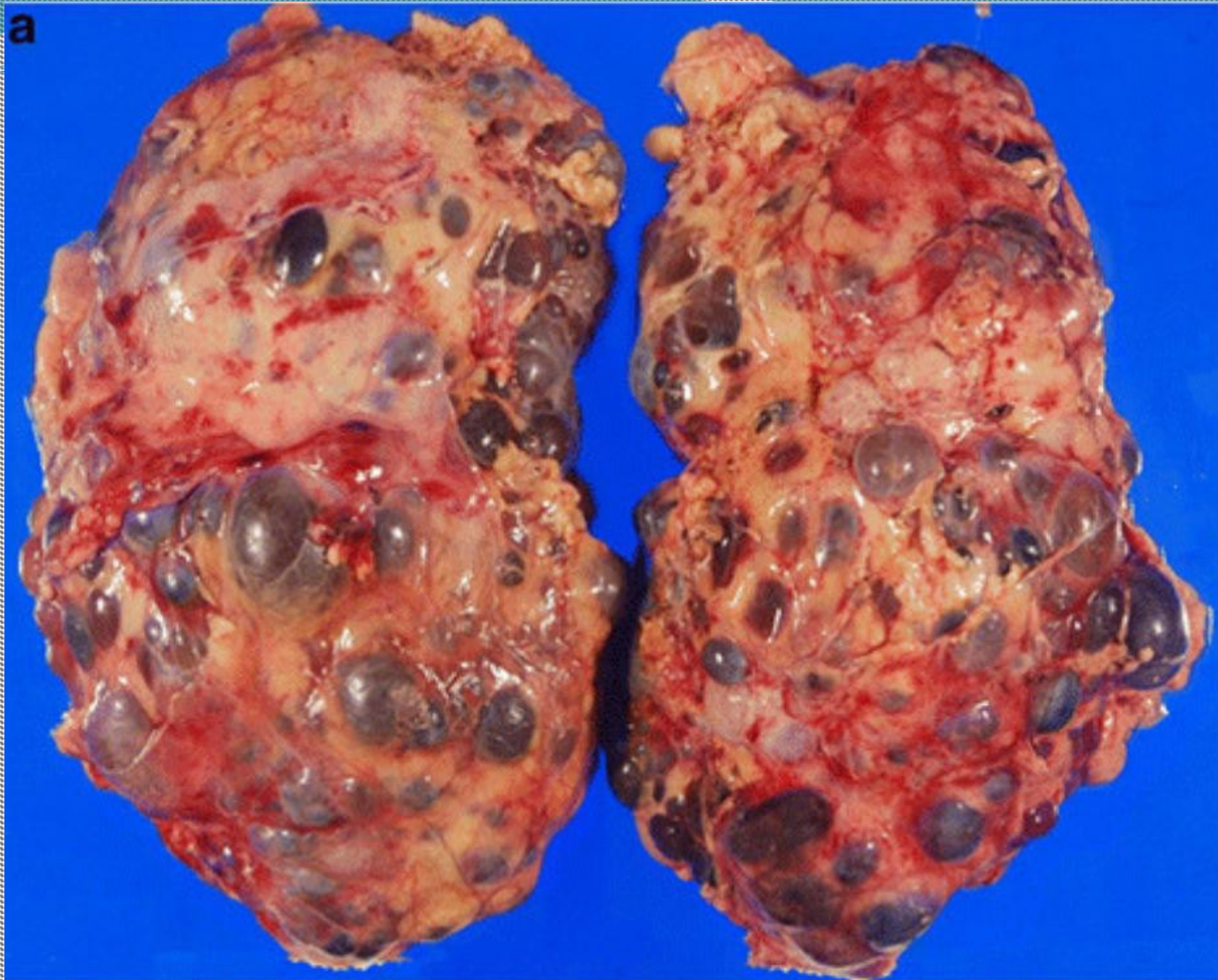




Horseshoe kidney

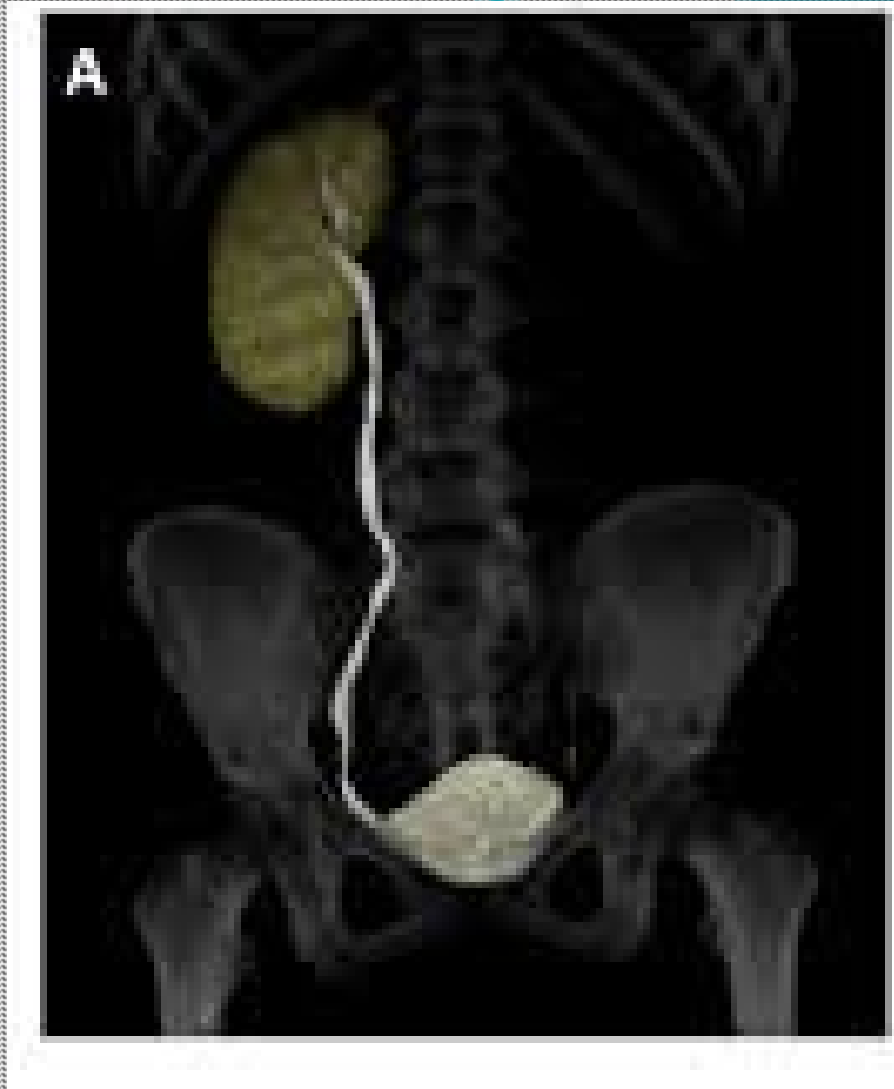
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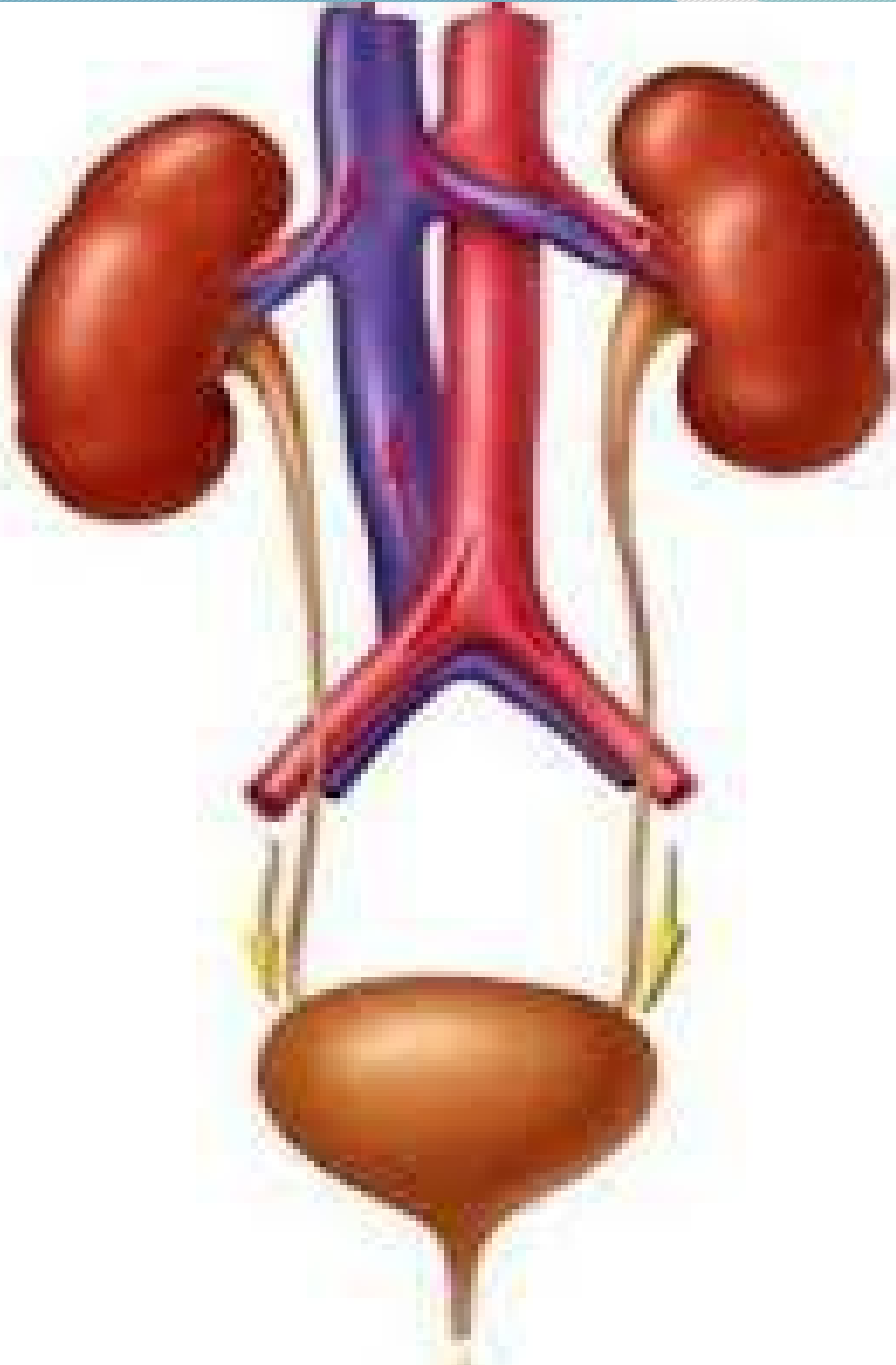


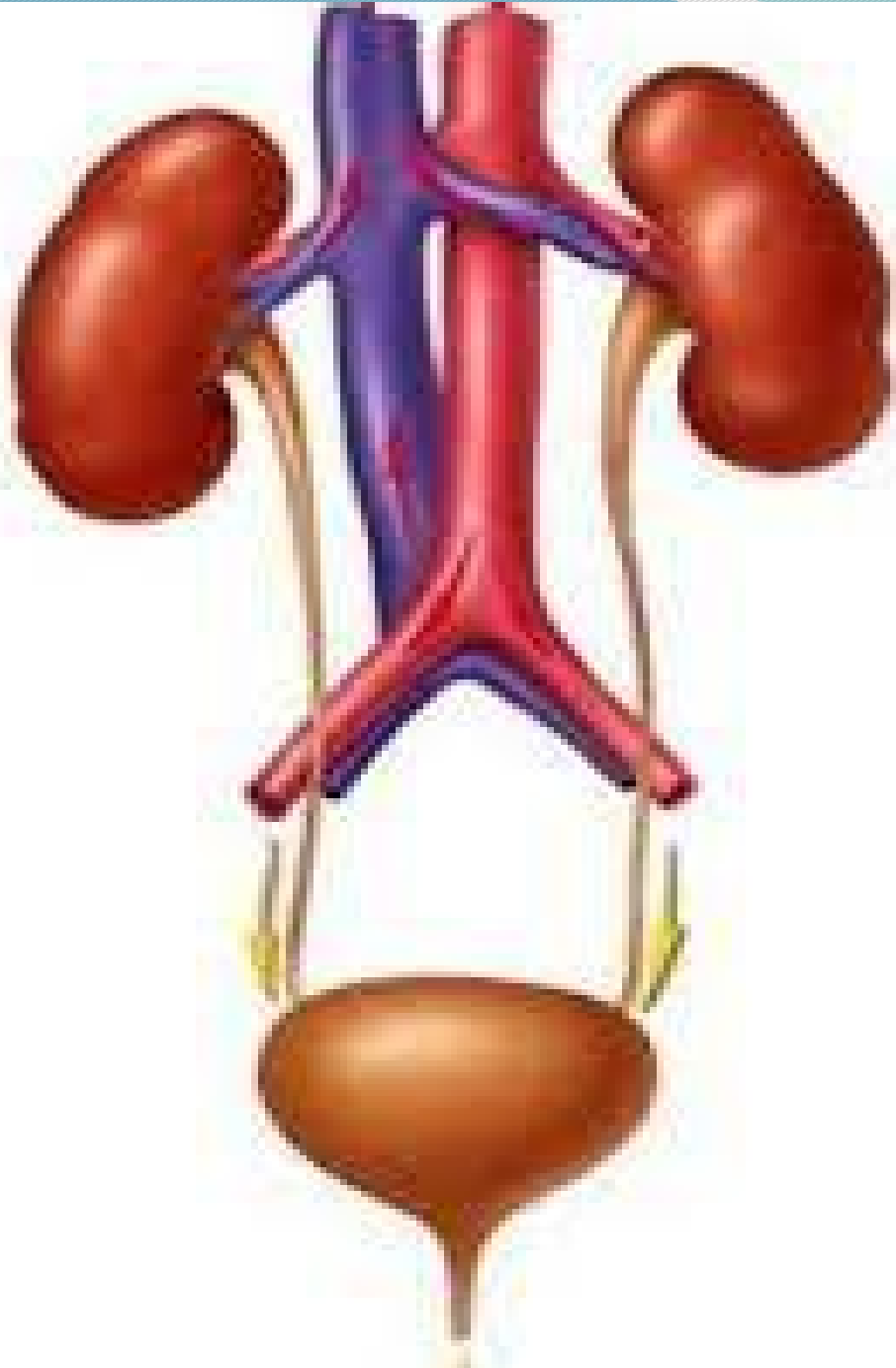
Polycystic kidney





Lt Renal agenesis





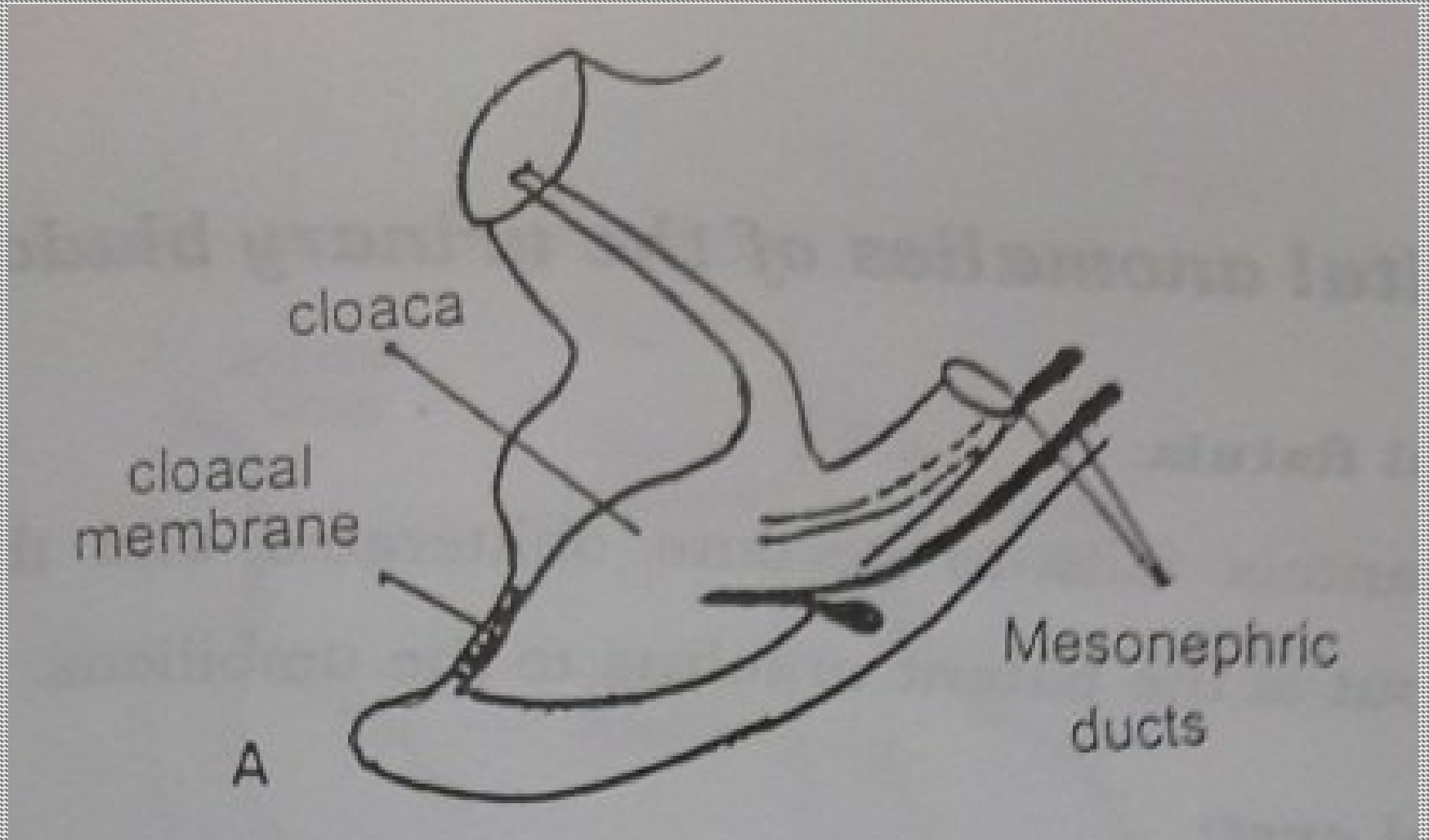
Normal
|
kidney



Development of Urinary Bladder

The cloaca is a dilatation in the terminal part of the hindgut. Its floor is closed by the **cloacal membrane**.

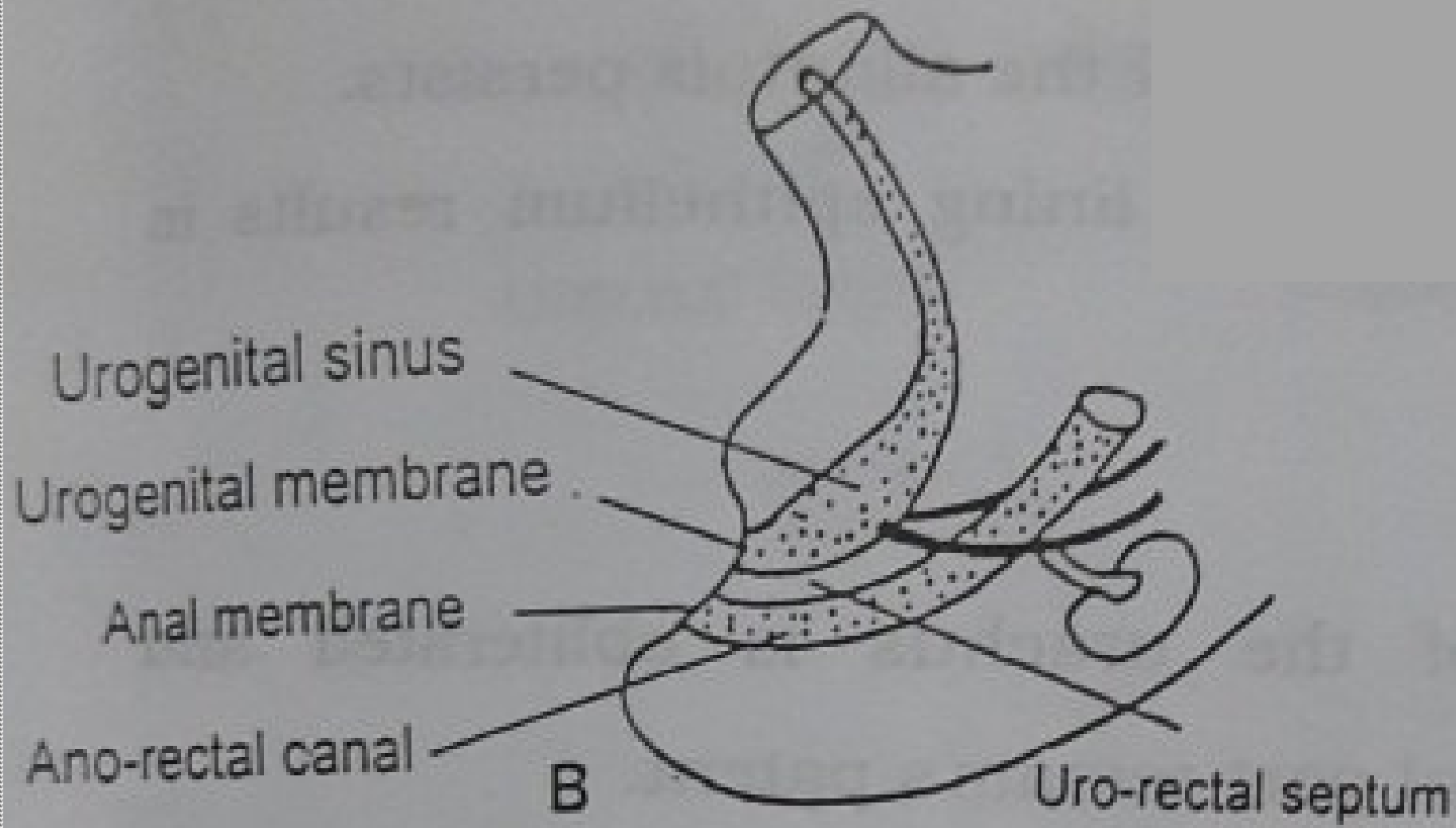
The cloaca receives three openings; allantois ventrally and the mesonephric duct, one on each side.



During 4th to 7th weeks of development, a septum of mesoderm (**urorectal septum**) divides the cloaca into the **primitive urogenital sinus** anteriorly and **anorectal canal** posteriorly .

Then, the urorectal septum divides cloacal membrane into urogenital membrane anteriorly and anal membrane posteriorly.

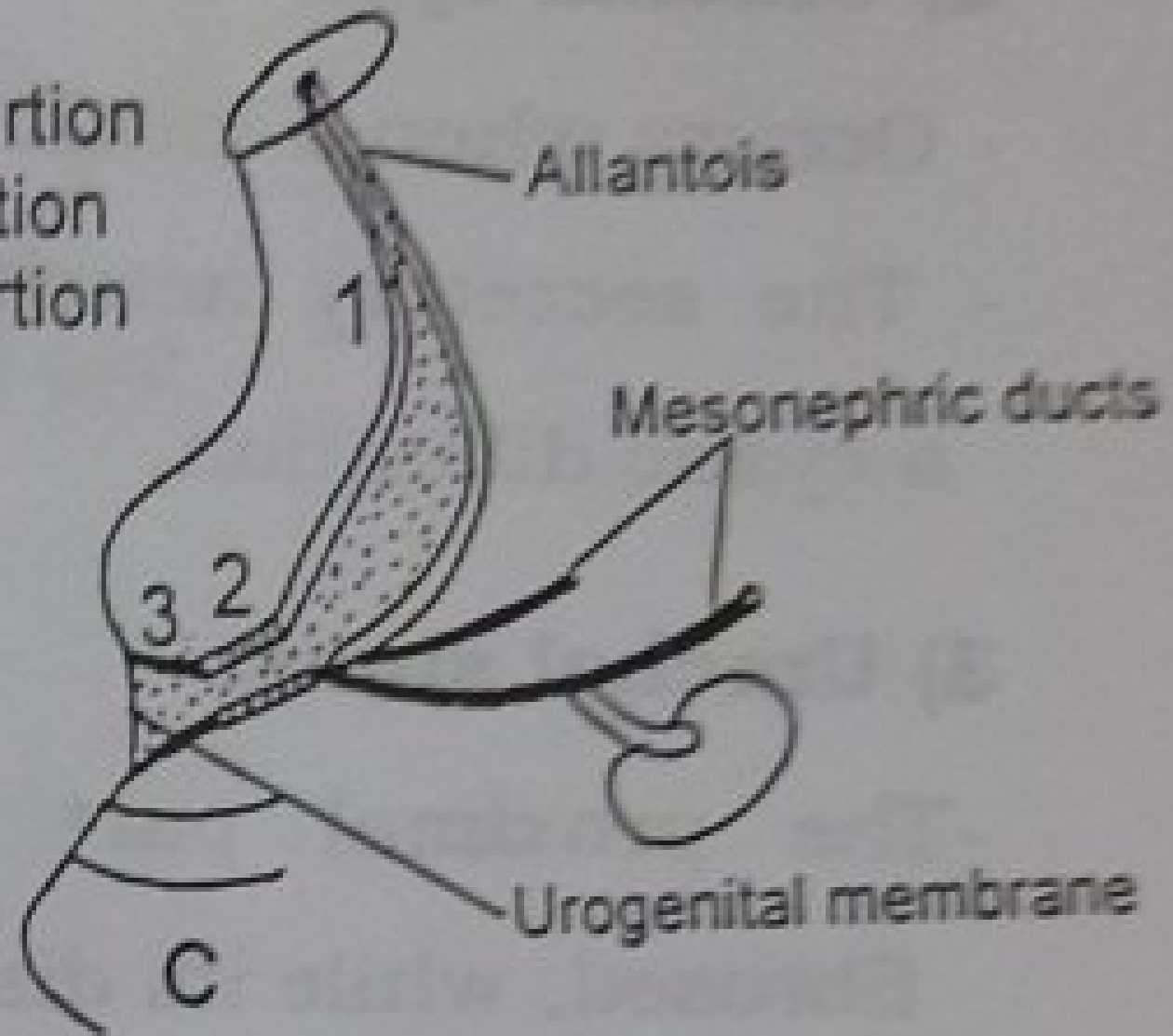
The primitive urogenital sinus receives the allantois and the two mesonephros ducts

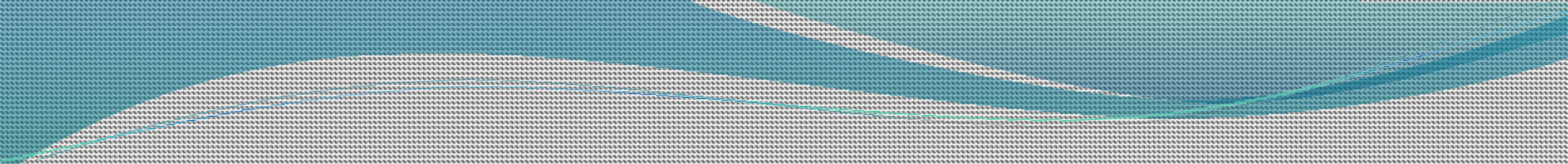


The entrance of the distal ends of the mesonephric ducts into the primitive urogenital sinus divides it into :

- 1) Upper part called the **vesico-urethral canal**
- 2) Lower part called the **definitive urogenital sinus** which further subdivided into :
 - a- Pelvic part
 - b- Phallic part which is closed by the urogenital membrane.

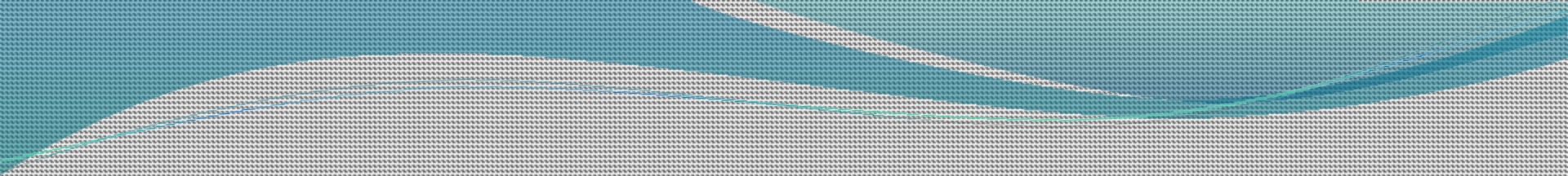
- 1-vesical portion
- 2-pelvic portion
- 3-phallic portion





The caudal parts of the mesonephric ducts become absorbed and incorporated into the wall of the bladder forming the **trigone** , so that the ureters and ducts have individual openings in the dorsal bladder wall.

With differential growth of the bladder, the ureters come to open through the lateral angles of the trigone and the mesonephric ducts open close together in the future prostatic urethra.



Thus :

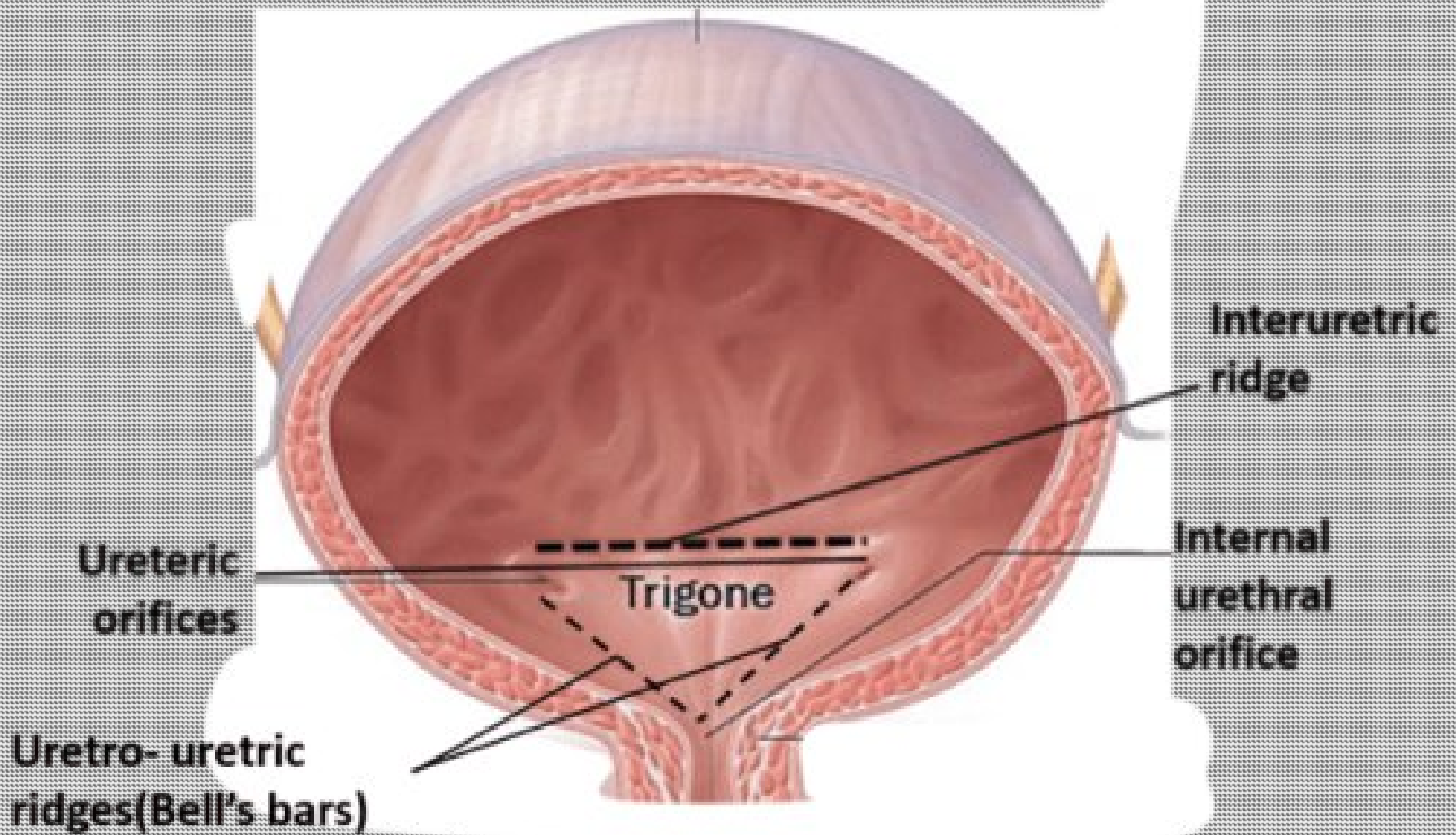
The greater part of the UB is developed from the upper part of the vesico-urethral canal.

The apical part is developed from the proximal part of the allantois

The distal part of the allantois is called urachus which becomes obliterated and fibrosed to form the median umbilical ligament.

The trigone of bladder :

- > Is mesodermal in origin in contrast to the remaining part which is endodermal.
- > It is developed from the lower parts of both mesonephric ducts.



Urinary Bladder Trigone

Congenital anomalies of urinary bladder

1- Urachal fistula

2- Urachal cyst

3- Urachal sinus

4- Ectopic vesica

Development of the urethra

In Female

develops from the vesico-urethral canal

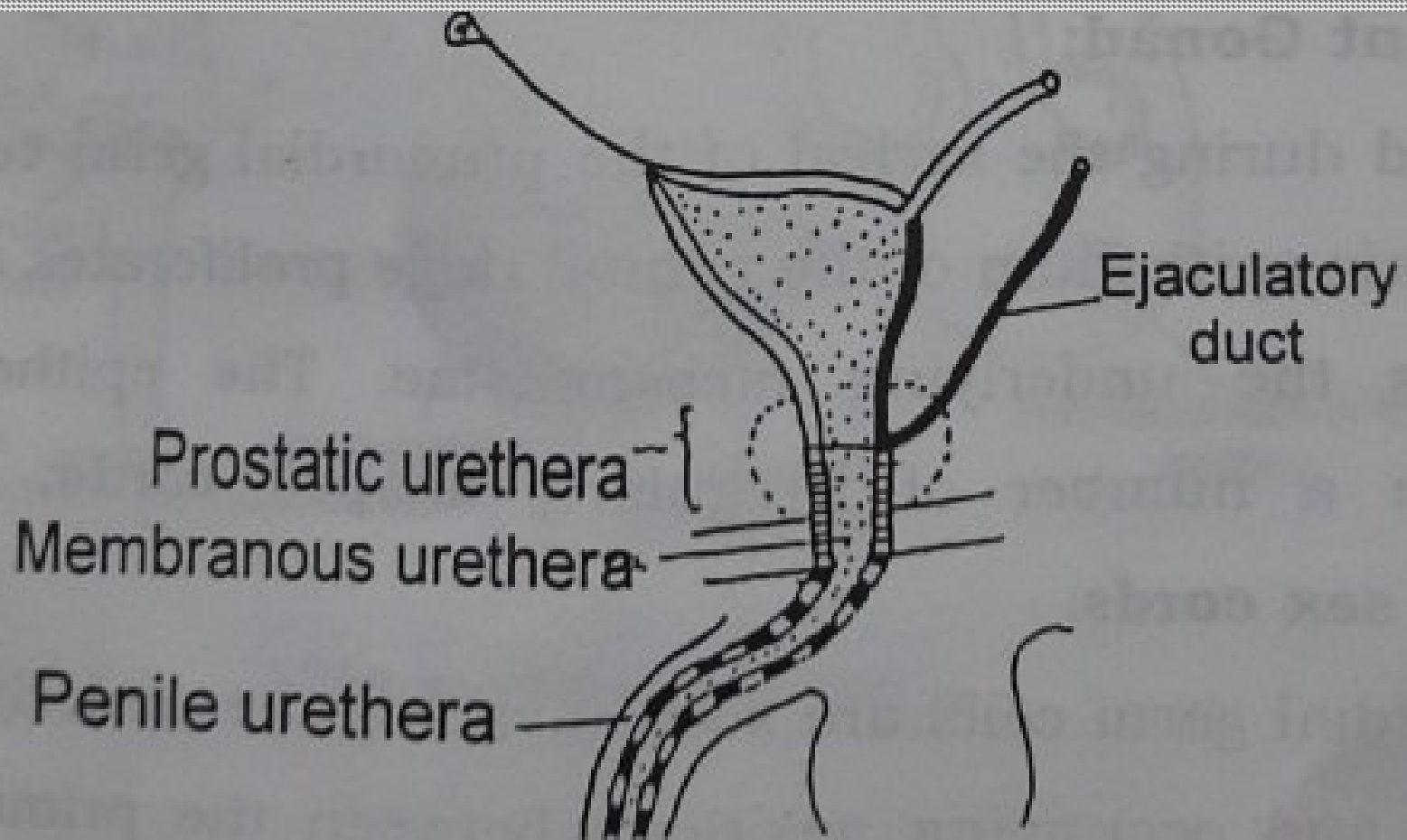
In Male

is formed of many parts which develop from different regions :

The upper part of **prostatic urethra** develops from the vescio-urethral canal

The lower part of **prostatic urethra** and **membranous urethra** develop from the pelvic part of the definitive urogenital sinus.

The **penile urethra** develops from the phallic part of the definitive urogenital sinus.



Development of urethra in male

