

Development Of Renal system

Renal block-Anatomy-Lecture 2,4





Objectives

Color guide :

Only in boys slides in **Green**

Only in girls slides in **Purple**

important in **Red**

Notes in **Grey**

At the end of the lecture, students should be able to:

Part (1) :

- Identify the embryological origin of kidneys & ureters.
- Differentiate between the 3 systems of kidneys during development.
- Describe the development of collecting & excretory parts of permanent kidney.
- Describe the fetal kidney & identify the pre- and postnatal changes that occur in the kidney.
- Enumerate the most common anomalies of kidneys & ureters.

Part (2) :

- Describe the cloaca and the formation of the urogenital sinus.
- Discuss the division of the urogenital sinus into various parts and name the adult organs that are derived from each part.
- Describe how the caudal parts of the mesonephric ducts and ureters are absorbed into the urogenital sinus and the significance of this embryonic event.
- Discuss the position of the urachus and its significance and fate.
- Describe the various anomalies concerned with the urinary bladder and urethra.

Development of Kidney

The embryonic ORIGIN of kidney and ureters is from **intermediate mesoderm**

intermediate mesoderm Divides into:

1. Nephrogenic ridge (cord): forms kidneys & ureters
2. Gonadal ridge: forms gonads (testes or ovaries)

❖ Three systems of kidneys develop:

Pronephric system:

- Appears in **cervical region**
- Analogous to kidney of **fish**
- Formed of tubules & a duct
- **Not function in human**
- **Disappears**

Metanephric system:

- Appears **pelvis**
- **Starts to function at 9th week**

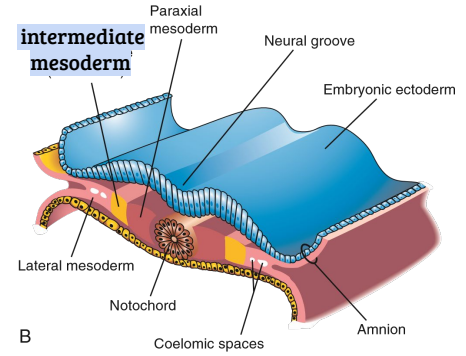
End of
week 4

Week 5

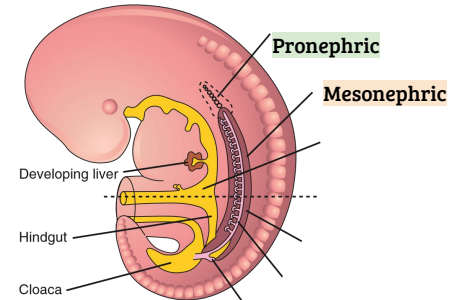
Start of
week 4

Mesonephric system:

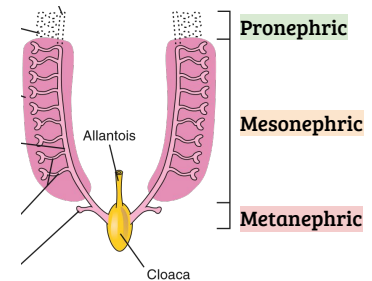
- Appears in **thoracic & abdominal regions**
- Analogous to kidney of **amphibians** (البرمائيات)
- Formed of tubules & a duct
- **Function temporarily**
- In male: forms genital duct
- In both sexes: forms ureteric bud



B



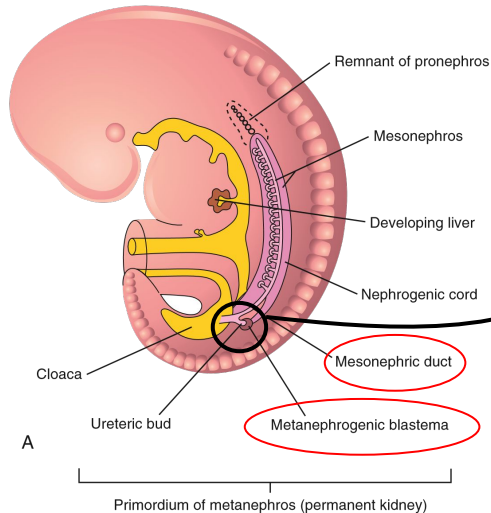
Metanephric



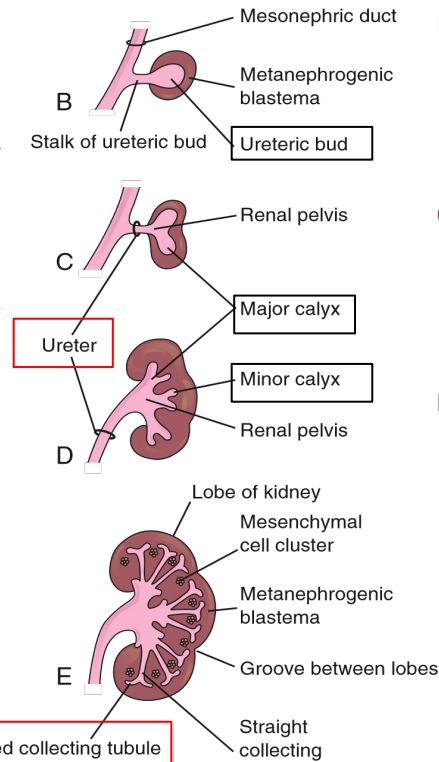
Metanephros (Permanent Kidney)

Formed of 2 origins:

- 1) Ureteric bud (derived from mesonephric duct): gives **collecting part** of kidney
- 2) Metanephric blastema (mass): gives **excretory part** of kidney



Collecting part



- B** Ureteric bud elongates & penetrates metanephric mass
- C** Stalk of ureteric bud forms **ureter** & cranial end forms **renal pelvis**.
- D** Branching of renal pelvis gives **3 major calyces**. Branching of major calyces gives **minor calyces**.
- E** Continuous branching gives straight then arched collecting tubules

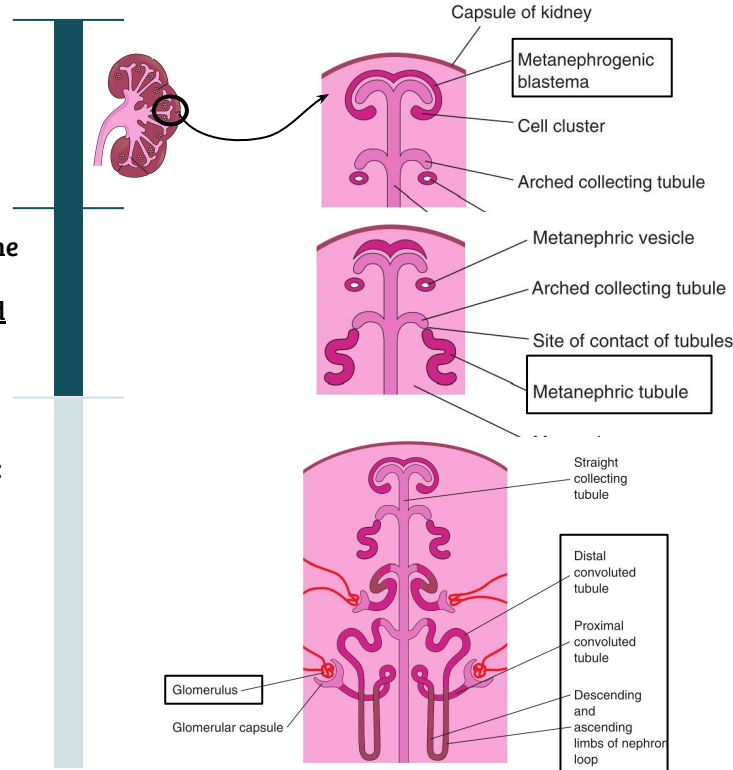
Metanephros (Permanent Kidney)

Excretory part

Each **arched collecting tubule** is surrounded by a cap of **metanephric mass**.

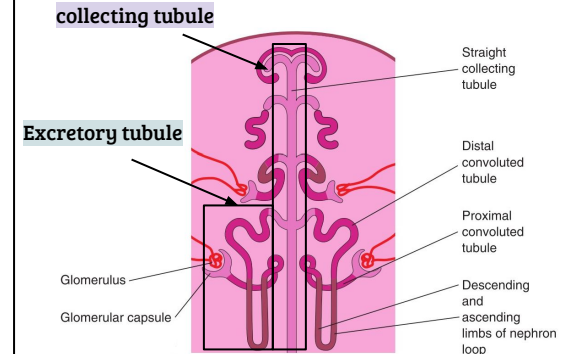
The metanephric cap forms the **metanephric vesicle**, which is elongates to form an **S-shaped metanephric tubule**.

-The tubule lengthens to form: **proximal & distal convoluted tubules + loop of Henle**
 -The end of each tubule forms **glomerular (Bowman's) capsule**, which is then invaginated by capillaries (glomerulus).



The Nephron

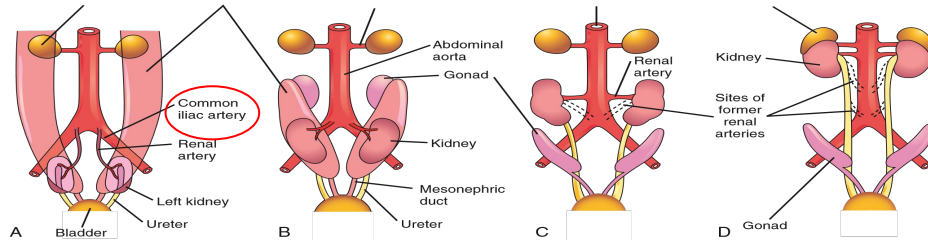
- It's the functional units of the kidney
- The nephron is formed by fusion of:
 1. **Excretory tubule** formed of **metanephric mass (cap)**.
 2. **Arched collecting tubule** formed of **ureteric bud**.
- At full term, each kidney contains: **800000 – 1000000 nephrons**.



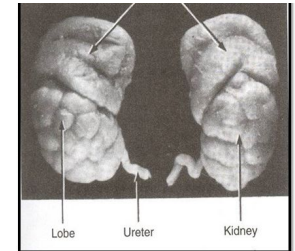
Changes in The Fetal Kidney

By week 9

- Change in position:** The kidney ascends from pelvis to abdomen & attains its adult position, caudal to suprarenal gland.
- Change in blood supply:** As the kidney ascends, its blood supply changes from renal branches of common iliac arteries into renal branches of abdominal aorta.
- Rotation:** Initially, hilum (site of entry & exit of vessels & nerves) is ventral then rotates medially about 90° & becomes medial.
 - Glomerular filtration begins
 - Kidney is subdivided into lobes that are visible externally.



Lobes of kidney



In full term (end of fetal period)

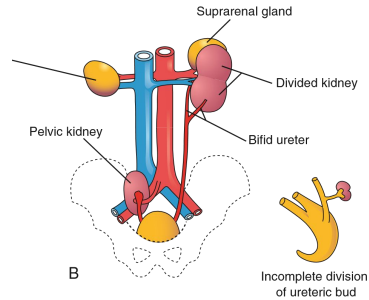
- Lobulation diminishes at the end of fetal period.
- Nephron formation is complete

After birth

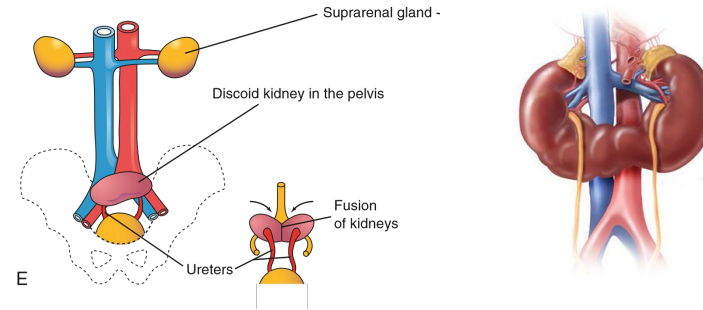
- Increase in size: due to elongation of tubules and increase in connective tissue between tubules (not due to increase in number of nephrons)
- Disappearance of kidney lobulation (usually disappear by the end of the first postnatal year)

Anomalies of kidney development

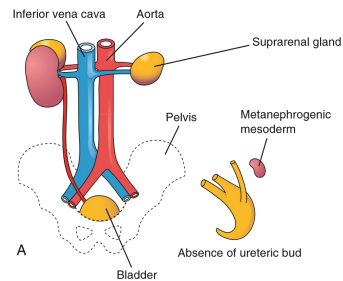
Pelvic kidney: failure of ascent of one kidney (ureter is short)



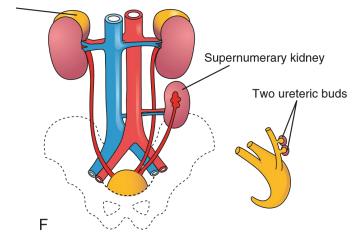
Horseshoe kidney: the poles of both kidneys (usually the lower poles) fuse: the kidneys have a lower position than normal but have normal function



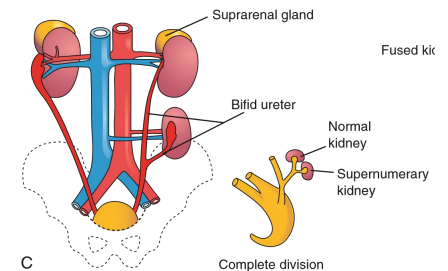
Unilateral renal agenesis: due to absence of one ureteric bud



Supernumerary kidney: due to development of 2 ureteric buds

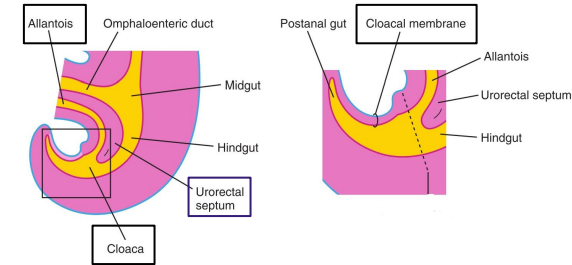


Right side: malrotation of kidney
Left side: bifid ureter & supernumerary kidney



Development of Urinary bladder and Urethra

- The **cloaca** is the dilated terminal part of the hind gut.
- It receives the **allantois** (anteriorly) and the (2) **mesonephric ducts**. (Laterally)
- Its floor is closed by the cloacal membrane.
- A mesodermal **urorectal septum** divides the cloaca and the cloacal membrane



Urorectal septum divides the cloaca and the cloacal membrane into:

Ventral part
(Primitive urogenital sinus) communicates with the allantois and the mesonephric ducts. Its floor is the urogenital membrane. (cranial end of cloacal membrane)

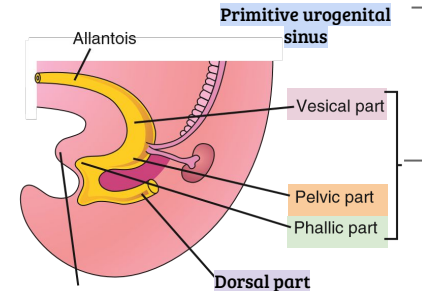
Dorsal part
the anorectal canal, that forms the rectum and upper part of anal canal. Its floor is the anal membrane. (Caudal end of cloacal membrane)

Subdivided into:

Cranial (vesical part) forms most of the **bladder** and continuous with the allantois.

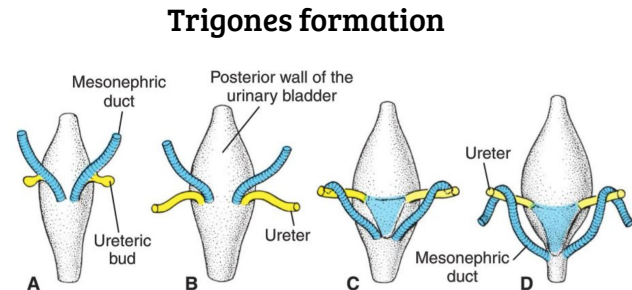
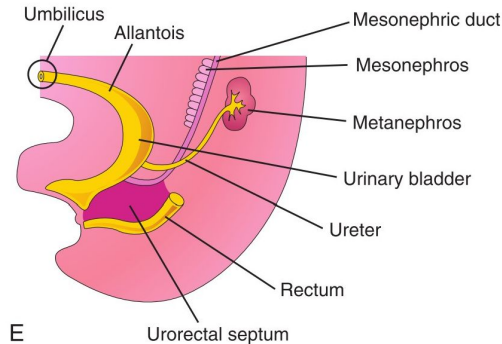
Middle (pelvic part) forms main part of **male urethra** (prostatic+membranous parts) and **entire female urethra**.

Caudal (phallic part) grows towards genital tubercle and **shares in the formation of the male urethra**.



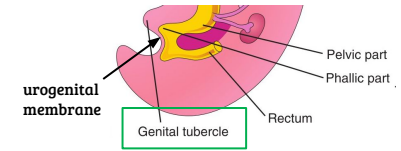
Urinary bladder

- ❖ It develops mainly from the **vesical part** of the **urogenital sinus**.
- ❖ The **trigone** is derived from the absorbed distal parts of the **mesonephric ducts**.
- ❖ The epithelium is **endodermal** in origin, of the urogenital sinus.
- ❖ The other layers are derived from the **splanchnic mesoderm**
- ❖ The **allantois** is at first continues with the bladder, then it becomes a thick fibrous cord called **urachus** which extends from apex of the bladder to the umbilicus, in adult it is represented by the **median umbilical ligament**.
- ❖ After absorption of the **mesonephric ducts** to form the **trigone**, the ureters open separately in the bladder.
- ❖ In infants and children the bladder is an **abdominal organ**.
- ❖ It starts to enter the greater pelvis at about 6 years and becomes a pelvic organ after puberty.



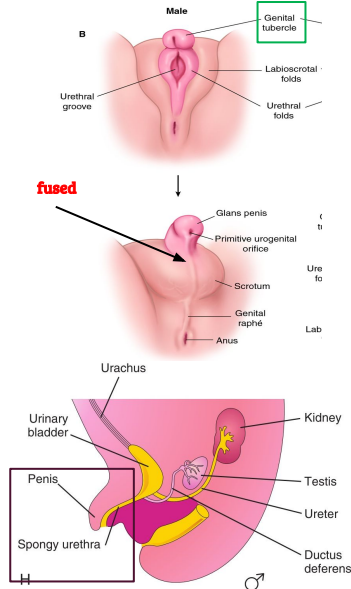
Urethra

The **genital tubercle** (mesenchymal elevation) develops at the cranial end of the cloacal membrane.
 Two urethral folds, develop on either side of the urogenital membrane.
 Laterally two labioscrotal, (cloacal) folds develop on either side of the **urethral folds**.



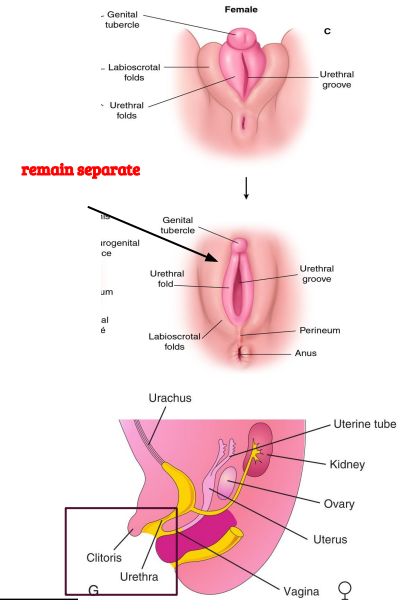
Male Urethra

- The **urethral folds** in male **fuse with each other** to close the **penile urethra**.
- Most of the male urethra prostatic, membranous and spongy parts is derived from endoderm of the **pelvic and phallic parts of urogenital sinus**.
- The **genital tubercle** elongates forming the phallus, which is the precursor of the penis.
- The most distal (terminal) part of male urethra in glans penis starts as ectodermal solid cord that grows towards the root of penis to meet the spongy urethra, later it canalizes.

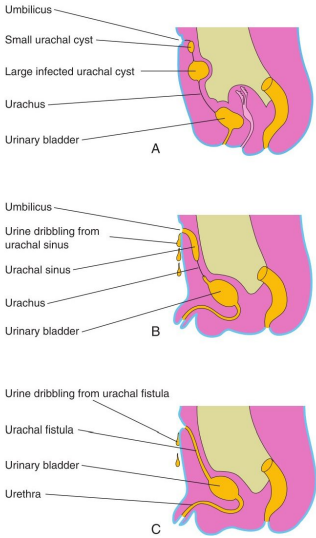
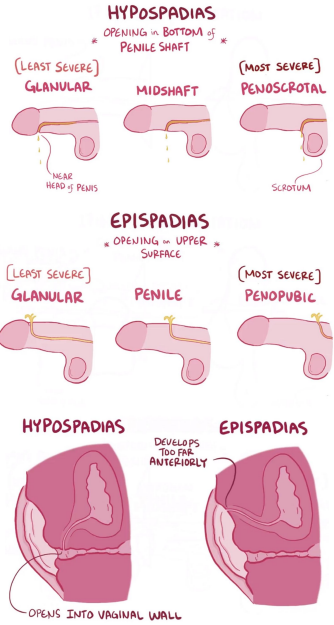
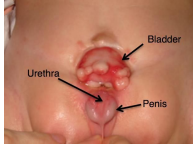
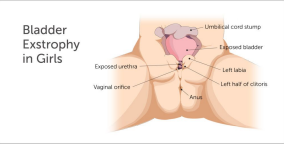


Female Urethra

- The **urethral folds** in female **remain separate** to form **labia minora**.
- The entire female urethra is derived from endoderm of the **pelvic part of the urogenital sinus**.
- The external urethral orifice opens dorsal to the glans clitoris.



Anomalies of u.bladder and urethra development

Urachal anomalies		Urethral Anomalies	
<p>A. Urachal cyst persistence or remnant of epithelial lining of urachus</p> <p>B. Urachal sinus, discharge serous fluid from the umbilicus.</p> <p>C. Urachal fistula, the entire urachus remains patent and allows urine to escape from the umbilicus.</p>		<p>Hypospadias : is the most common anomaly, with incomplete fusion of the urethral folds, and abnormal openings of the urethra occur along the ventral (inferior) aspect of the penis.</p> <p>Epispadias : is a rare abnormality, in which the urethral meatus is found on the dorsum of penis, it is most often associated with exstrophy of the bladder.</p>	
<p>Exstrophy of the bladder (Ectopia vesicae) exposure of the posterior wall of the bladder due to a defect in the anterior abdominal wall and anterior wall of the bladder.</p>			



Summary

Kidneys & ureters

- originates from nephrogenic ridge (cord) of **intermediate mesoderm**.
- During development, 3 systems appear:
 1. **Pronephric**: in cervical region, not function.
 2. **Mesonephric**: in thorax & abdomen, function temporarily, mesonephric duct gives ureteric bud.
 3. **Metanephric**: in pelvis, permanent kidney.
- Ureteric bud gives: ureter + **collecting part** of kidney (calyces, straight & arched collecting tubules).
- **Metanephric mass** gives: **excretory part** of kidney (Bowman capsule, proximal & distal convoluted tubules, loop of Henle).

By 9th week

At full term

After birth



1. Glomerular filtration begins.
2. Kidney attains its adult position.
3. Kidney receives its arterial supply from aorta.
4. Kidney completes rotation.

1. Nephron formation is complete.
2. Lobulation of kidney diminishes

1. Lobulation of kidney disappears.
2. Kidney increases in size due to elongation of existing tubules **not due to increase in number of nephrons**.

Urinary bladder

- It develops mainly from the **vesical part** of the **urogenital sinus**.
- The **allantois** is at first continues with the bladder, then it becomes a thick fibrous cord called **urachus** which extends from apex of the bladder to the umbilicus
- The epithelium is endodermal in origin, of the urogenital sinus.
- The other layers are derived from the splanchnic mesoderm
- After absorption of the **mesonephric ducts** to form the **trigone**, the ureters open separately in the bladder.

Urethra

- The **genital tubercle** develops at the cranial end of the cloacal membrane.
- Male urethra
 - **The urethral folds** in male **fuse with each other**
 - Most of the male urethra derived from endoderm of the **pelvic** and **phallic parts** of **urogenital sinus**
- Female urethra
 - **The urethral folds** in female **remain separate**.
 - The entire female urethra is derived from endoderm of the **pelvic part** of the **urogenital sinus**.

MCQs

Question 1: Which one of the following events happens by 9th week?

- A. Nephron formation is complete
- B. Disappearance of kidney lobulation
- C. Kidney attains its adult position
- D. Metanephric system appears

Question 2: Which one of the following structures is a derivative of the ureteric bud?

- A. Major calyces
- B. Loop of Henle
- C. Proximal convoluted tubule
- D. Glomerulus

Question 3: the blood supply of the kidney before week 9 ?

- A. Common iliac arteries
- B. Suprarenal artery
- C. Branches of common iliac arteries
- D. Branches of abdominal aorta

Question 4: Supernumerary kidney happen due to ?

- A. absence of one ureteric bud
- B. development of 2 ureteric buds
- C. failure of ascent of one kidney
- D. short ureter

Question 5: In infants and children the bladder is an -----organ.

- A. thoracic
- B. abdominal
- C. pelvic
- D. central

Question 6: The trigone is derived from ?

- A. splanchnic mesoderm.
- B. absorbed proximal parts of the mesonephric ducts
- C. urogenital sinus
- D. absorbed distal parts of the mesonephric ducts

Question 7: female urethra is derived from ?

- A. endoderm of the phallic part of the urogenital sinus.
- B. ectoderm of the pelvic part of the urogenital sinus.
- C. mesoderm of the pelvic part of the urogenital sinus.
- D. endoderm of the pelvic part of the urogenital sinus.

Question 8 : which of the following Anomalies is most often associated with exstrophy of the bladder.

- A. Hypospadias
- B. Epispadias
- C. Urachal cyst
- D. Urachal fistula

Team members

Boys team:

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- Rawan Al Zayed
- Renad Al Haqbani
- Nouf Al Humaidhi
- Jude Al Khalifah
- Nouf Al Hussaini
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- Rema Al Mutawa
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THANKS!

Contact us:



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