DEVELOPMENT OF THE KIDNEYS

Embryology
436

﴿ إِنَّا خَلَقْنَا الإنسان مِنْ نُطْفَةٍ أَمْشَاجٍ نَبْتَلِيهِ فَجَعَلْنَاهُ سَمِيعًا بَصِيرًا ﴾]الإنسان.[2 :

Revised by

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MEDICINE

KING SAUD UNIVERSITY

- Important
- Dr. notes
- Explanation

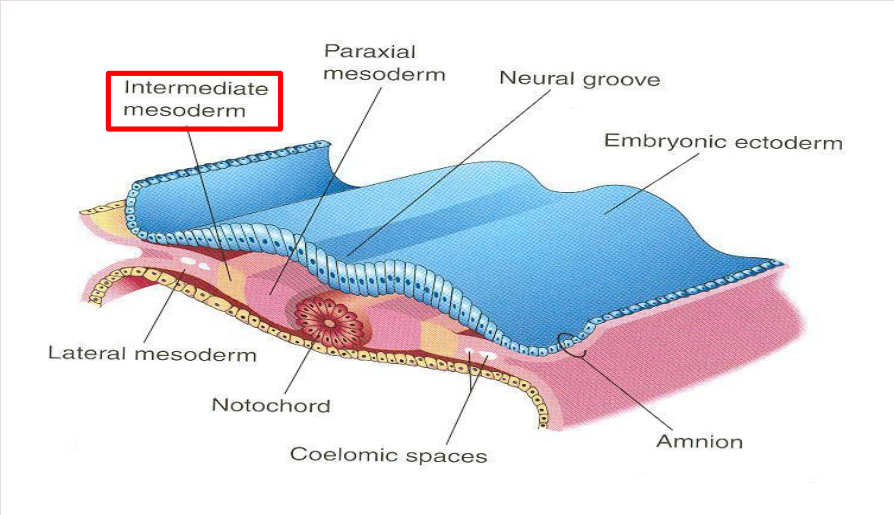
- We recommend you to study anatomy of the kidney lecture first.

OBJECTIVE

- 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.

Embryological Origin

- There are three layers of mesoderm which are parietal ,lateral and intermediate mesoderm .However, just one of them contains the kidney and ureter which is **intermediate mesoderm.**



- Embryological origin of **kidney** and **ureter** is from intermediate mesoderm

- **intermediate mesoderm differentiates into:** (two elevation).

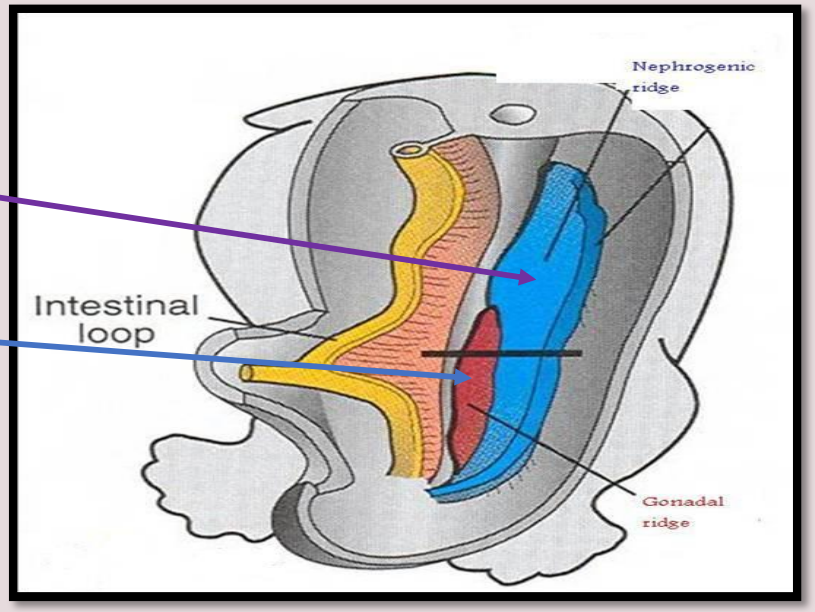
1. Nephrogenic ridge (cord) (lateral) :
forms kidneys and ureters.

2. Gonadal ridge (medial):
forms gonads (testes or ovaries).

video for extra explanation

Nephrogenic ridge

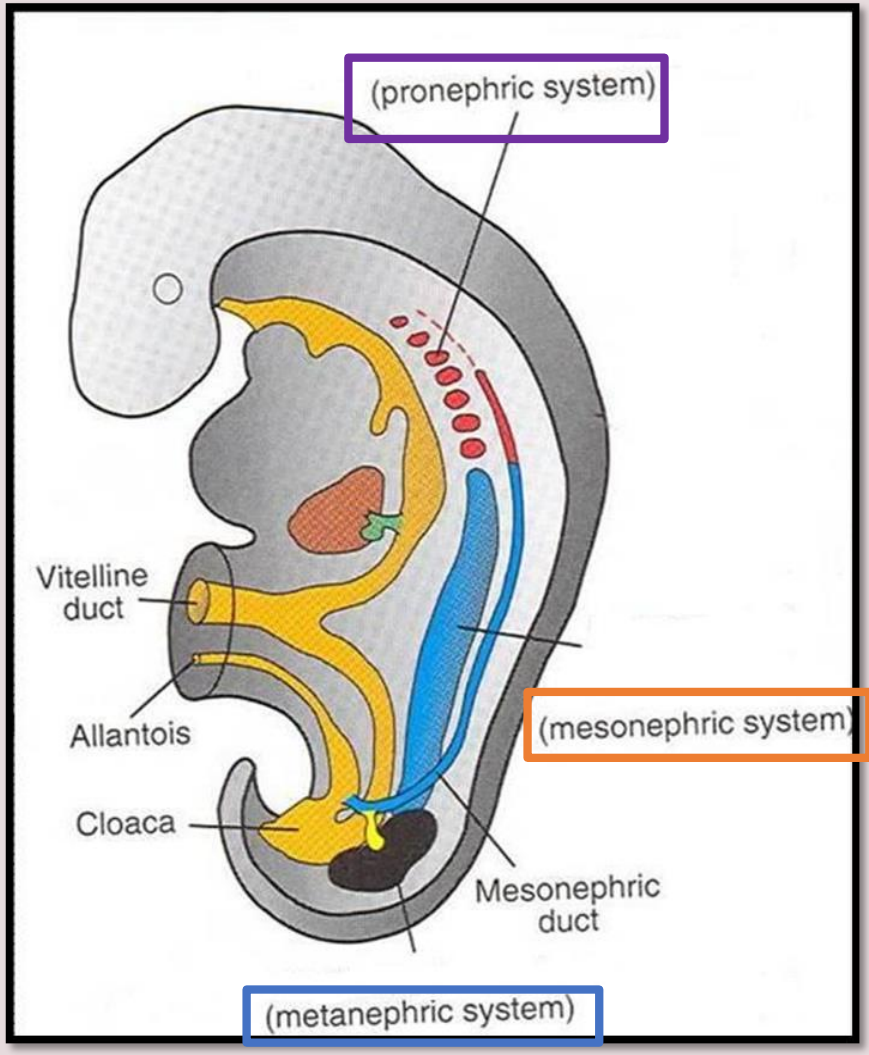
Gonadal ridge



Development Of Kidney

❖ Three Systems The Kidneys Develop:

1. Pronephric system:	2. Mesonephric system:	3. Metanephric system:
• appears at beginning of 4th week in cervical region (upper part of nephrogenic pool) • analogous to kidney of fish تشبه شكل كلية الأسماك • formed of tubules تبدأ ب and a duct وتنتهي بـ • not functional in human • disappears (temporal) • Only tubules will disappear.(duct is available). الكدني تكون موجودة في ال . سيرفيكال ريجون فتتشكل في بداية الأسبوع الرابع Upper part of nephrogenic pool وهي عبارة عن Tubules open in duct	• appears at end of 4th week in thoracic and abdominal regions • analogous to kidney of amphibians تشبه شكل كلية الزواحف • formed of tubules and a duct • Function but temporarily • The duct: In male: forms genital duct • genital duct transfer the sperm from testes to urethra • In both sexes: forms ureteric bud • In males the mesonephric duct will be part of the genital system , while in female it will disappear except the most lower part it will form ureteric bud, so in both sexes the lower part will form ureteric bud	• appears at 5th week in pelvis • starts to function at 9th week • * Very important * This system will give the permanent kidney

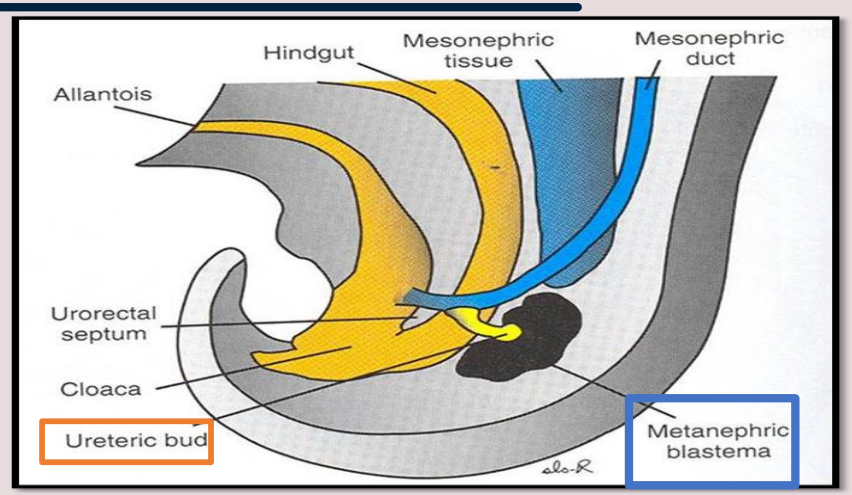


Videos for extra explanation:
Pronephros
Mesonephros
metanephros

Metanephros (Permanent Kidney)

Metanephros: is permanent kidney.
Formed of 2 origins:
1- Ureteric bud (derived from distal end of mesonephric duct) : (يجمع البول)
gives collecting part of kidney.

2- Metanephric blastema (mass): (from most lower part of nephrogenic cord).
gives excretory part of kidney. (الجزء الي يستخلص وينقي الدم)



(COLLECTING PART)

A- Ureteric bud elongates and penetrates metanephric mass.

(ميسونفرك دكت يخرج منها يوريترك بد صغير يوصل بينهم (stalk)زي عنق وبعدين يبدا اليوريترك بد والعنق يصيروا أطول)

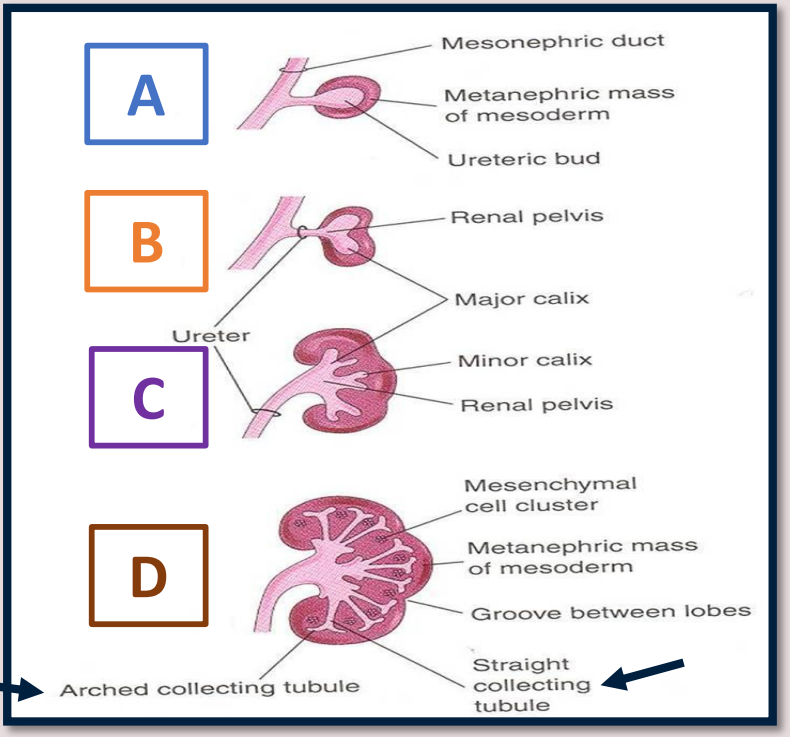
B- Stalk of ureteric bud forms ureter and cranial end forms **renal pelvis**.

C- Branching of renal pelvis gives **3 major calices**. Branching of major calyces gives **minor calyces**.

(بعدين اليوريترك بد تدخل داخل الميتانفرك ماس وتبدا تتفرع ويعطينا 3ميجور كاليسز وتتفرع اصغر وتعطينا 3 ماينور كاليسز).

D- Continuous branching gives **straight** then **arched collecting tubules**.

مع استمرار التفرع يعطينا استريت تيبيولز ونهايتها في ارش
وكل هذا داخل ميتانفرك ماس وبعدين هيصير تغيرات فيها عشان تعطيني Excretory part

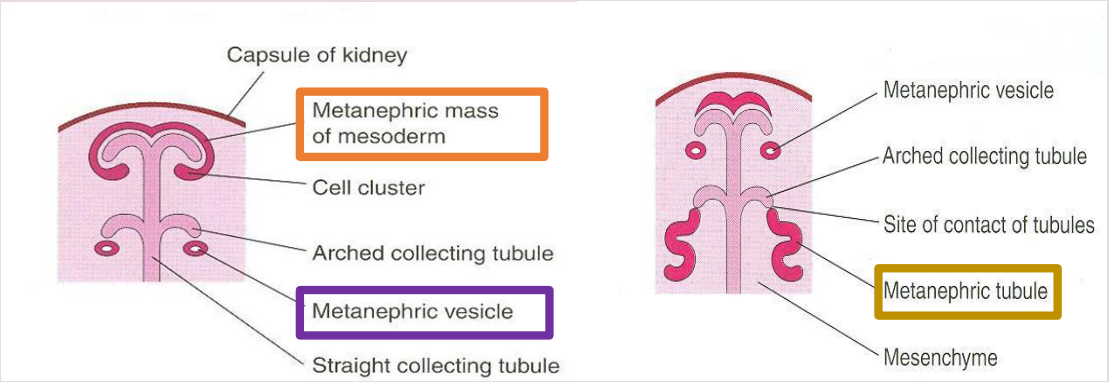


Excretory Part

- Each arched collecting tubule is surrounded by a cap of **metanephric mass**.
- The metanephric cap forms the **metanephric vesicle**.

ميتانفرك ماس عبارة عن قطعة وحدة تحيط بكرينيال اند اوف يريترك بد
يوريترك بد يبدا يتفرع ويقسمها لقطع وكل قطعة تحيط ب ارش كوليكتنق تبيولز
في هذه الحالة نسمي القطعة (Metanephric vesicle)

- The metanephric vesicle elongates to form an S-shaped **metanephric tubule**.



"EXCRETORY PART (CONT)."

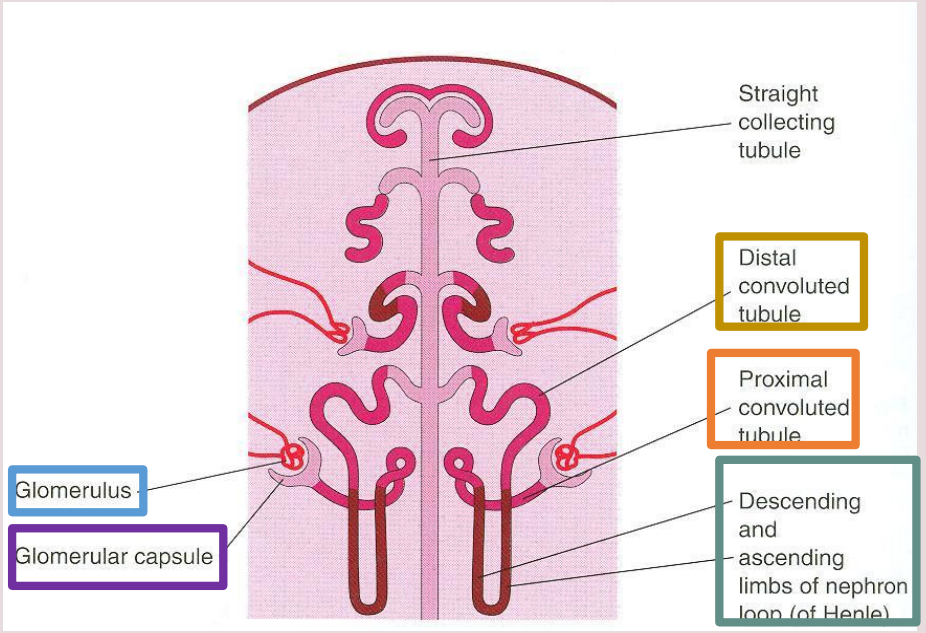
- The end of each tubule forms **glomerular (Bowman's) capsule**.

(S-shape tubules become more longer form cup shape called (bowman's capsule)

- Each glomerular capsule is invaginated by capillaries **(glomerulus).**

- The tubule lengthens to form: **proximal** and **distal** **convoluted tubules** + **loop of Henle**.

الاس شيب تيبيولز تطول اكثر وتنطوي وتعطينا
: proximal and distal convoluted tubules + loop of Henle



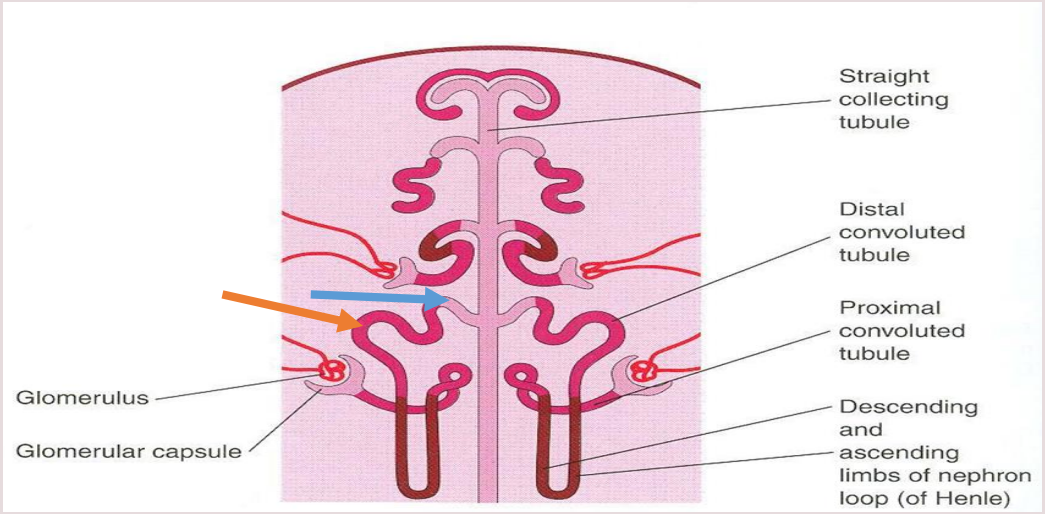
The Nephron

- **The nephron**: functional unit of kidney.
- The nephron is formed by **fusion** of: (collecting part +excretory tubules)

1.**Excretory tubule** formed of **metanephric mass** (cap).

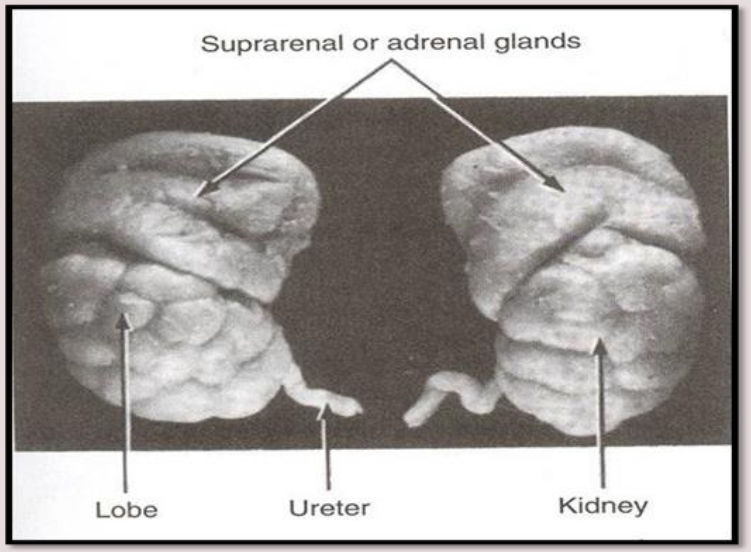
2. **Arched collecting tubule** formed of **ureteric bud**.

- Each kidney contains: **800000 – 1000000 nephrons**.
- No more nephrons formed after birth



CRITERIA OF THE FETAL KIDNEY :

- Kidney is subdivided into **lobes** that are visible externally.
- Lobulation **diminishes** at the end of fetal period.
- Nephron formation is **complete at birth** .
- No more nephron is formed after birth .



- The difference between kidney in adult and fetal:

fetal : small size , has lobes that can see with eye and disappear at the end of the fetal.
Adult: large size , has no lobes (if it has lobes (abnormal)) .

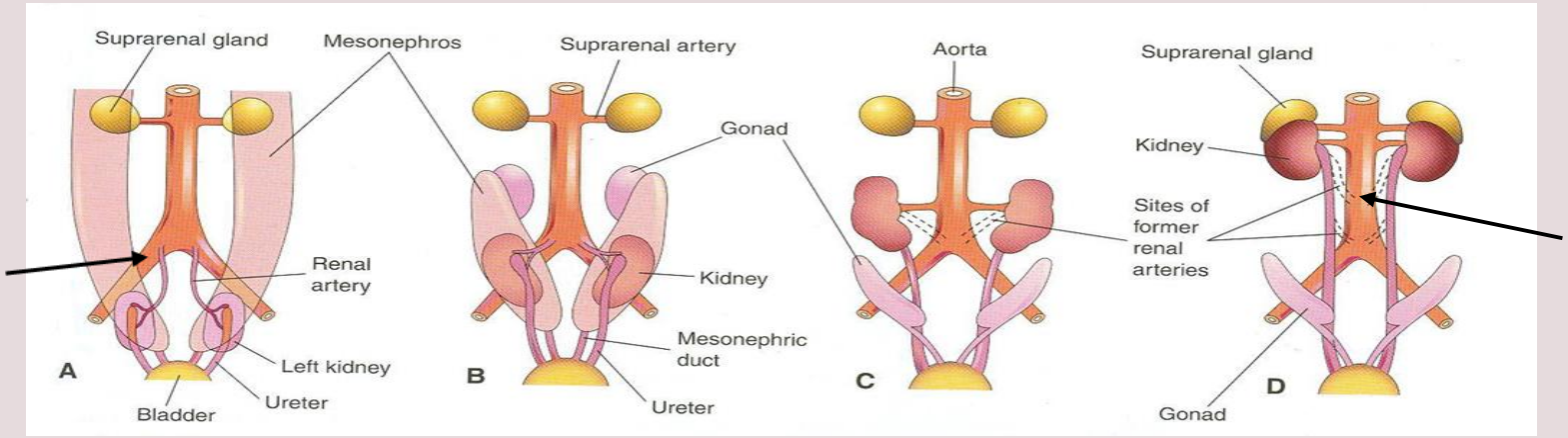
Changes Of Kidney Before Birth

- **Changes during development:**(by 9th week).

1. Change in position: The kidney ascends **from pelvis to abdomen** and attains its adult position, **caudal to suprarenal gland**.(صار أطول لما توصل ل سبرارينال قلاند ف يوقفها من انها تطلع اكثر Body trunk تطلع لفوق بسبب ان)

2.Change in blood supply: As the kidney ascends, its blood supply changes from renal branches of common iliac arteries (pelvis) into **renal branches of (abdominal aorta)** (abdomen).

3.Rotation: Initially, **hilum** (site of entry and exit of vessels and nerves) is ventral then rotates medially about 90° and becomes **medial**.



Common iliac artery

Abdominal aorta

Video for explanation

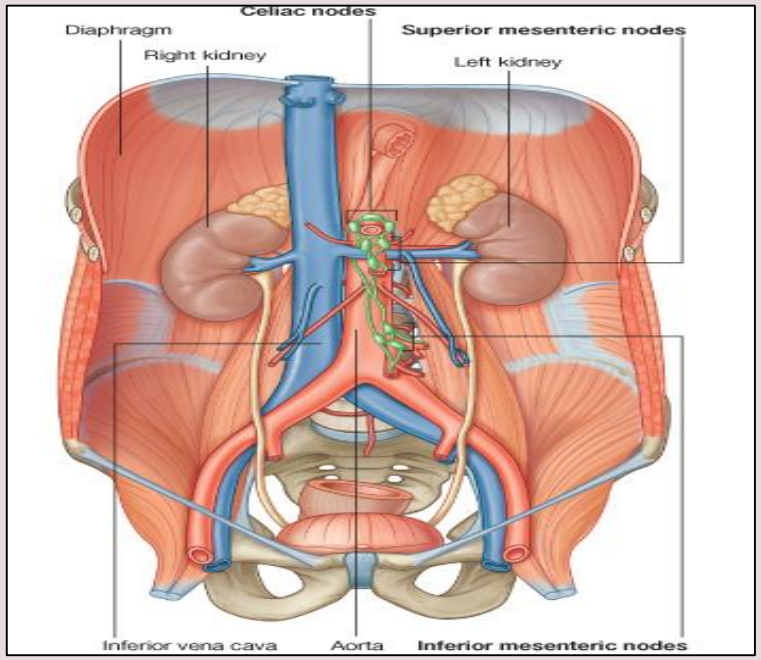
The Fetal Kidney

- What happens at the 9th week ?! **(This week is very important for the kidney).**

- beginning of glomerular filtration (**start of function**).

- The kidney attains its **adult position** **at the level of L2** and receives its supply from **renal artery**(abdominal aorta).

- The hilum is rotated **medially.**
- Kidney is subdivided into lobes that are visible externally. Lobulation diminishes at the end of fetal period.



- Changes of kidney 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**.

*مهم جدا نعرف ان الكدني بعد الولادة ماتزيد في عدد النيفرونز.

يبدا ال (لوبس)بالاختفاء في فترة ماقبل الولادة ويختفي تماما بعد الولادة

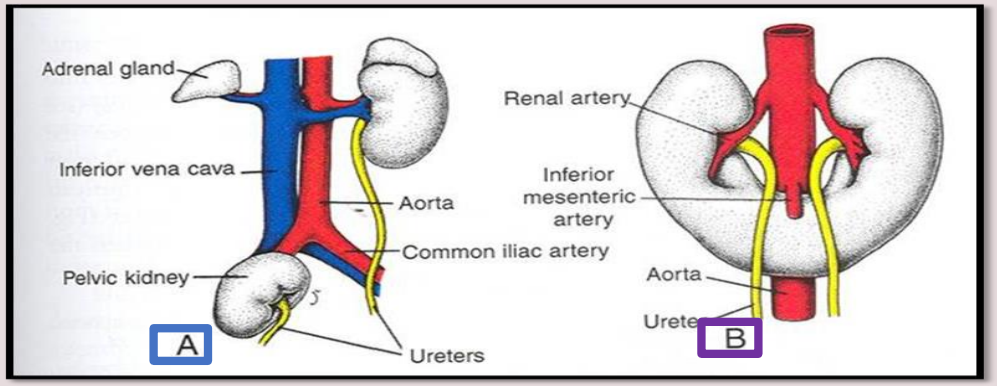
Congenital Anomalies

A- Pelvic kidney: failure of ascent of one kidney (ureter is short)
(الكدني هتكون في البيلفك وهي المفروض تكون في الابدومن وبالتالي اليوريتر يكون قصير).

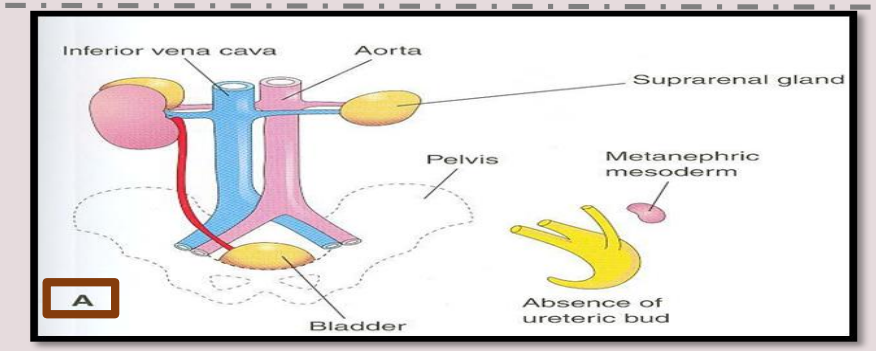
B-Horseshoe kidney:(على شكل حذوة الحصان)**(very common):** the poles of both kidneys (usually the lower poles) fuse: the kidneys have a lower position than normal but have **normal function**.

ايش خطورته ؟!

The fusion will cause compression of inferior mesenteric artery which originate from abdominal aorta , and supplies large intestine(transverse colon,left desceniging colon and rectum) so all these areas will be affected.



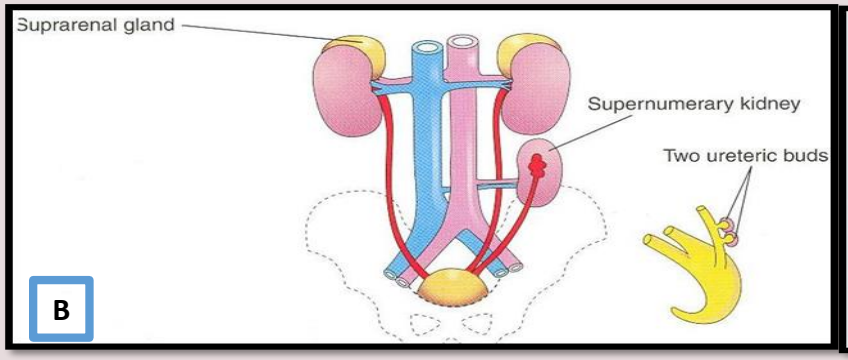
A- Unilateral renal agenesis: due to absence of one ureteric bud.
There will be one kidney. (جهة هيكون فيها يوريترك بد وتكونت من خلالها الكدني وحدة و وجهة الأخرى مافيها يوريترك بد بالتالي ما هيكون عندي كدني).

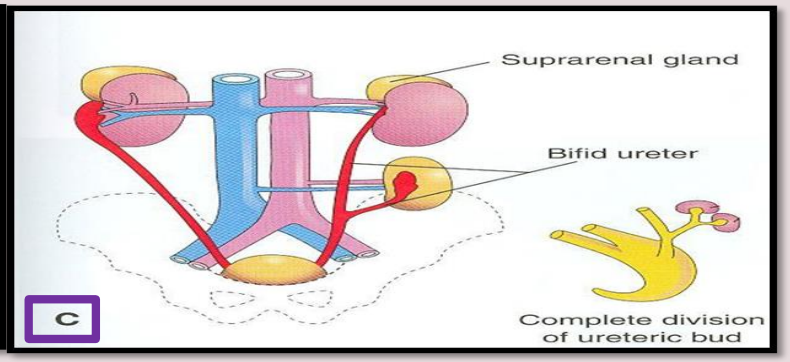


B- Supernumerary kidney: due to development of 2 ureteric buds(in one side).
هيكون عندي اكثر من يوريترك بد في جهة وحدة بالتالي اكثر من كدني هتتكون كل وحدة عندها ureterخاص فيها

C- Right side: malrotation of kidney .(No rotation)
Left side: bifid ureter (one ureter will divide to two) and supernumerary kidney.
So there will be two kidneys with one ureter.

helium of kidney will be in lateral side جهة اليمين
جهة اليسار هيكون فيه اكثر من كدني مشتركة في one ureter





Picture (c) : has 2 anomalies

Summary

Date	Event
Beginning of 4th week	Pronephric system appears
End of 4th week	Mesonephric system appears
At 5th week	Metanephric system appears(in pelvis)
9th week (very very important)☺	Metanephric system starts working
	Glomerular filtration starts
	The kidney reaches its adult position and receives new blood supply(abdominal aorta)
	Hilum rotates medially
End of fetal period	Disappearance of lobulation
At birth	Nephron formation is complete

Congenital anomalies	
Pelvic kidney	Failure of ascent of one kidney(short ureter)
Horseshoe kidney	Fusion of kidney lobe (normal function)
Unilateral renal genesis	Absence of one ureteric bud
Suprenumerary kidney	Development of 2 ureteric buds(in one side)
Malrotation of kidney	Ventral hilum (facing front)
Bifid ureter and supernumaray kidney	The ureter itself splits into two ureters

Questions

1-Which one of the following systems forms ureteric buds:

a- Mesonephric system b-metanephric system c-pronephric system d-nephrogenic cord.

2-what is the cause of enlargment of kidneys after birth:

a-increased number of nephrons b-increased blood supply c-elongation of tubules d- disapearance of lobes.

3- Ureteric bud gives which part of the kidney:

a-collecting part b-excretory part .

4-nephron formation is complete at:

a-4thweek b-5thweek c-9thweek d-at birth.

5-glomerular filtration starts at:

a-4thweek b-5thweek c-9thweek d-at birth.

6-the kidneys change it's arterial supply to renal branch of aorta from:

a-superior mesenteric arteries b- suprarenal arteries c-common iliac arteries d-splenic artery.

1-a
2-c
3-a
4-d
5-c
6-c

ANY SUGGESTION OR ISSUE

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Editing file

USEFUL VIDEOS

https://youtu.be/yigznAyhnGo?t=19
https://www.youtube.com/watch?v=W76SYjJDHwA

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